KNOWLEDGE
AN ILLUSTRATED MAGAZINE OF SCIENCE, LITERATURE & ART.

LONDON: MAY 1, 1896.

CONTENTS.

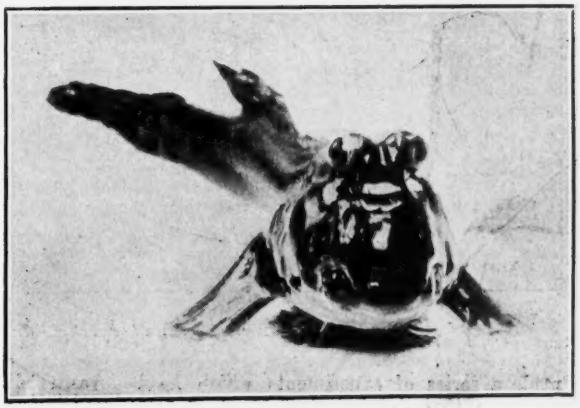
	PAGE
The "Walking" Goby. By HENRY O. FORBES, LL.D. (*Illustrated*)	97
English Coins.—I. By G. F. HILL, M.A. (*Plate*) ...	98
Some Curious Facts in Plant Distribution.—II. By W. BOTTING HEMSLEY, F.R.S.	102
Our Fur Producers.—III. Foxes, Wolves, and Bears. By R. LYDEKKER, B.A.Cantab., F.R.S. (*Illustrated*) ...	103
Science Notes	106
Variable Stars. By Dr. A. BRESTER, Jz.	107
The Nebulosity round 15 Monocerotis. By E. WALTER MAUNDER, F.R.A.S. (*Plate*)	109
Notices of Books. (*Illustrated*)	109
Letters:—E. WOHLWILL; W. H. S. MONCK; T. LAW WEBB, M.R.C.S.; E. BROWN; W. H. A. COWELL; W. G. BUSZARD; Rev. SAMUEL BARBER; W. E. BESLEY ...	112
Waves.—V. The Tide Wave. By VAUGHAN CORNISH, M.Sc. (*Illustrated*)	113
Babylonia and Elam Four Thousand Years Ago. By THEO. G. PINCHES, M.R.A.S. (*Illustrated*)	116
The Face of the Sky for May. By HERBERT SADLER, F.R.A.S.	118
Chess Column. By C. D. LOCOCK, B.A.Oxon.	119

THE "WALKING" GOBY.

By HENRY O. FORBES, LL.D.,
Director of Museums to the Corporation of Liverpool.

THE naturalist haunting at ebb tide the sea-shores of the Indian or West African tropics, especially where they are muddy, cannot fail to have his attention arrested by a crowd of curious tadpole-like creatures which stampede before him. He will come upon them congregated together in large numbers, sitting basking in the hot sun a few inches above the water line, either on soft, muddy flats, or in the mangrove swamps, where they seem to delight to sit upon the branching roots of those trees. On his approach, off they will scamper at a headlong pace by frog-like leaps, some into the shallow water, others along the shore into safe hiding. If he proceeds, however, very guardedly, he may advance within a short distance of some of them; he will then perceive that, though enjoying themselves on land, they are true fishes.

The species is *Periophthalmus koelreuteri*, the "hopping fish" of the trader, one of the gobies (*Gobiidæ*). Their tadpole-like look arises from their tapering tail and curiously prominent eyes, which stand up high above the level of the head. It is an elegant little beast, with skin covered with minute scales, and its dorsal fins beautifully spotted with bright blue. If the observer remain quite still, the *Periophthalmus* will sit motionless, staring at him with its great eyes, except that every now and then it will wink apparently, sometimes with one eye and sometimes with both together. What seems to be winking, however, is the inversion of the eye into a depression immediately under it, for the purpose of lubricating the organ when it begins to become dry. The habit that most impresses the naturalist encountering these fishes for the first time is the long period which they can remain out of the water. The writer has timed individuals, both in their native state and in the aquarium, to sit for more than half an hour without a bath. They would then walk slowly into the water, immerse themselves over the head for a second, emerge and remain resting for a short time, with the head and shoulders above and the mouth under the surface, and walk slowly out again on to the margin. This fish rarely, if ever, goes beyond its depth, and only for a few seconds does it at any time completely submerge itself. Their usual habit is to sit propped up on their stiff ventral and strong pectoral fins, with the fore part of the body elevated, and their quick mobile eyes conspicuous and enquiring; either, as already remarked, entirely away from the water, or with only the extremity of the tail dipping in. When out of the water and sitting still the mouth is kept closed, and no motion can be detected in the gills or gill-coverts. Every now and then the eyes are moistened as described above, and the fish flaps its pectoral fins across the gill-coverts and the hind part of the head. When the tide has just receded and the small marine animals are beginning to follow it, they are very busy darting here and there in pursuit, and gobbling them up voraciously. They will even attack and eat smaller members of their own species.



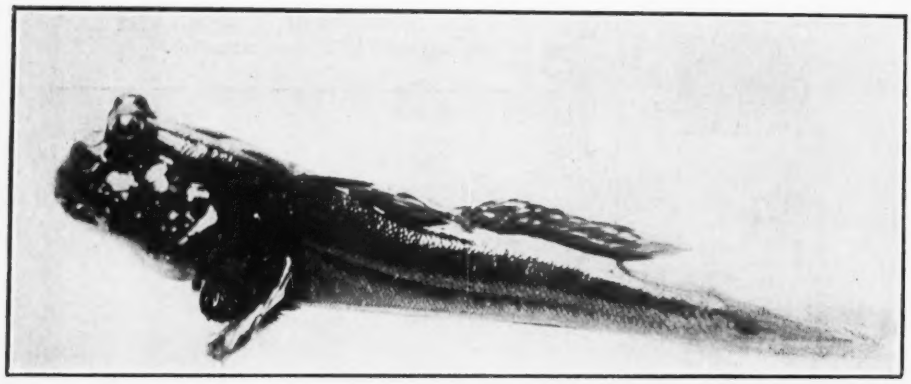
Periophthalmus koelreuteri.—Front view.

When moving forward they oar themselves on their strongly muscular pectorals, which they use simultaneously when hopping or alternately in their more deliberate "walking," which leaves a curious triple track on the soft mud which they have traversed. When in the water the *Periophthalmus* sits on the bottom in the same attitude as on shore, with its upper lip submerged, but with the rest of the head and upper part of the back exposed, the water being driven over its gills very slowly and deliberately as compared with the common trout in an adjoining tank. Its eyes are better adapted for sight out of than under water, and are capable of seeing all round. They are amazingly quick: the slightest wriggle of a worm or small crustacean, even at several feet distance directly behind them, will be instantly detected, and the creature at once pounced upon—often by more than one at once, in which case a battle ensues, resulting frequently in each combatant carrying

off a share of the prey. The precise structure of the eyes of the "walking" goby is not yet known, though the present writer hopes shortly to be able to give some account of specimens which are now being prepared, and are nearly ready, for histological examination. They seem, however, to differ from the eyes of the Cyprinodont *Anableps*, in which the upper portion is adapted for vision out of water and the lower for vision under water, the fish swimming with the one half above and the other beneath the surface.

The first specimens of *Periophthalmus* which have been imported into Europe were brought from West Africa a few months back for the Liverpool Museum. They have lived remarkably well in a shallow salt-water tank, which has been kept as evenly as possible at a temperature of from seventy-five to eighty degrees Fahrenheit. Though on their arrival they were extremely timid, they became after a short time quite tame, and came to recognize the attendant who fed them, eagerly watching for food on his approach.

Professor Haddon, who studied this species in Australia, being struck with the length of time these fishes could remain out of water, and with the fact that many of them sat by the margin of the sea with extremity of the tail immersed, thought that perhaps this part of its body served as a subsidiary organ of respiration. He accordingly made a series of experiments which he believes tends to prove that the tail does assist in respiration. The manner, however, in which the specimens in the aquarium of the Liverpool Museum have been observed to sit on dry land, under close scrutiny, for lengthy periods, distant from the water, leads the writer to suspect that no aid can be lent to respiration by the immersed portion of the tail. The gill chambers are capacious, and it is probable that a sufficient amount of water can be retained in them to keep up respiration during their absence from the sea.



Periophthalmus koelreuteri.—Side view.

The *Periophthalmus koelreuteri* is widely distributed, being found throughout the Indian and Melanesian seas and on the west coast of Africa. It is absent, however, according to Dr. Gunther, from the Eastern Pacific and from the American side of the Atlantic. It is exceedingly nimble, and can be captured only with the greatest difficulty; and he who would succeed must count on being smeared from his hat to his boots with evil-odoured mud.

The accompanying illustrations are reproduced from photographs of the specimens in the Liverpool Museum, taken directly from life while sitting out of the water. They are, we believe, the only representations of this fish so obtained, the figures in Dr. Gunther's "Study of Fishes," and in Moseley's "Notes of a Naturalist on the *Challenger*," being drawn from spirit-preserved specimens.

ENGLISH COINS.—I.

By G. F. Hill, M.A.

THIS paper must begin with an apology for its title. In the first place, it deals briefly with a coinage which existed in our country before the advent of the English race; and, secondly, some notice must be taken of the coinages of Scotland and Ireland. In these, however, there is little to justify a longer title than has been adopted.

The first coinage of Britain must be traced back to a Greek original. In a previous paper* we saw that the gold staters of Philip II. attained an extremely wide currency throughout the whole ancient world. It has been proved by the chief authority on the subject, Sir John Evans,† that the most important type of the early gold coins of Britain goes back to the stater of Philip. Greek influence probably reached Britain through Gaul, and the barbarous Gaulish imitations of Greek coins were still more barbarously and unintelligently imitated by the Britons. As we might expect, the coinage of Britain seems to have begun in Kent, and spread thence along the southern and eastern coasts, and to a certain extent into the Midlands. If we allow about a century and a half from the time of Philip (who died in 336 B.C.), we may arrive at a probable date for the beginning of coinage in Britain. The plate (Figs. 1 and 2) shows two barbarous Gaulish copies of Philip's coinage, and (Figs. 3 foll.) some specimens of British money. Fig. 3 (from the south-eastern district) is clearly derived from the Greek, but the charioteer has been provided with wings. In barbarous hands the tendency to reduce everything to mere ornament is strong, and in Fig. 4 (from the south coast) the original is hardly to be made out. The opposite tendency to evolve a likeness out of a mere design also, however, exists; and it is not difficult to see how the boar on Fig. 7 has been developed out of the degenerate human face on Fig. 5, through the intermediate stage of Fig. 6.

The coins described above are all of gold or silver, but baser metals were in use. The coins of the Channel Islands are of very base character, copper being the chief constituent, though silver and tin also form a part. The piece here given (Fig. 8) is characteristic in style. These coins probably belong to some time in the first century B.C.

Roman influence began to be felt in the time of Julius

* Knowledge, June 1st, 1895, p. 123.

† "Ancient British Coins," pp. 17, ff.

Cæsar, and was soon strongly shown by the coinage. As the coins now begin to bear inscriptions, they supplement to a certain extent the too scanty records of British history. Thus, *e.g.*, we have coins with the names of rulers like Verica, Tasciovanus, Epaticcus, and Cunobelinus, and places like Camulodunum (Colchester) and Verulamium (St. Alban's). Of the four rulers mentioned only the last (Shakspeare's Cymbeline) is known from history; but the coins show that Epaticcus and Cunobelinus were sons of Tasciovanus. The name of Epaticcu(s) appears on the reverse of the gold piece No. 9, and the obverse legend TASCI F (*i.e.*, Tasciovani Filius) gives us his parentage. No. 10, again, gives us the first four letters of Cunobelinus on the reverse, and those of his mint, Camulodunum, on the obverse. Tasciovanus, who ruled over the Catyeuchlani, had Verulamium for his capital; his son Cunobelinus received, perhaps in his father's lifetime, the eastern kingdom of the Trinobantes, with the capital Colchester.

The coins struck by various Roman Emperors (or usurpers) in Britain, of which an instance is given in a previous paper,* do not properly come within the scope of this article. We must therefore pass over the period of Roman imperial domination to that which begins with the first advent of the English. An interesting coin (or possibly ornament) illustrates the transition from the one period to the other (No. 11). That it is a copy of a solidus of the Roman Emperor Honorius is clear; but the legend is unintelligible, and the reverse bears an obscure Runic legend. The piece was therefore made by people using Runes (that is, the script developed by the Scandinavian nations out of the Latin alphabet of about the fourth century A.D.); and it is said to have been found in this country. It may be dated approximately 600 A.D.

The series of English coins proper begins in the early years of the seventh century—probably soon after the conversion to Christianity of Æthelberht, King of Kent, in 596 A.D.—with what is known as the sceat† series. This is a remarkable series of small coins, the character of which is similar to that of the Merovingian currency of the Franks. While, however, the latter was mainly and primarily a gold coinage, there is only a comparatively small class of English coins in this metal, which was soon replaced by silver. This Merovingian currency, originating in an imitation of Roman money similar to the gold coin with Runic letters which we have already described, soon acquired a distinct character of its own. Both the solidus and its third (*triens* or *tremissis*) were coined by the Merovingians, but the latter eventually became almost the sole denomination—at least in England. The name *tremissis* is the origin of the old English word thrymsa, a money of account, and probably originally the name of the small coins corresponding to the Merovingian tremisses.

Besides the general resemblance there are many other small points which, taken together, prove the connection between the coinages on the two sides of the Channel. One coin in particular bears the name of a Merovingian moneyer (Eusebius) on one side, and on the other the name of Canterbury (DOROVERNIS CIVITAS). There are also coins which appear to be English imitations of Merovingian pieces.

Of the gold coins here illustrated, No. 12 is an imitation of a Roman coin. The legend is unexplained, though apparently not blundered; the reverse is taken from a coin which represented two emperors seated holding the globe of sovereignty, with a figure of Victory behind them. No. 13, on the other hand, is probably imitated from Merovingian money; the legend, which is WVNƎƎTTON, may possibly, as has recently been suggested, be the name of Winchester (Wintonia). These coins have nothing to connect them directly with the English, but another coin of similar fabric in the British Museum with a Runic legend may serve to establish the connection. The silver coins, or sceats proper, have a great variety of types. Three, with reverses evidently derived from the Roman type of the military standard inscribed VOT XX (*i.e.*, vows made on the Emperor's accepting the empire for twenty years), are illustrated here (Nos. 14-16). The first has on its obverse a degraded bust, with a Runic legend equivalent to EPA in front of it. The second shows on its obverse a pattern which can actually be traced back to a human head looking to the right. The third shows the same type in an altered form, where the "artist" has evolved a strange bird out of the degraded form of head. It would be easy to multiply the fantastic types; but we must be content to notice one or two sceats for which some historical connection can be established. The first of these belongs to a series which bears in a more or less blundered form the name of London (No. 17). The second (No. 19) bears the name (in Runic letters) of Pada, and is naturally to be connected with Peada, King of Mercia (A.D. 655-656 or 657). The type of the reverse is the degraded standard type which we have already noticed. Another (No. 18) similarly gives us the name of Æthelred of Mercia (675-704).

Before leaving this early period we must mention the early coinage of a district of England which we have up till now left out of account: the district north of the Humber. The earliest known coins of this district belong to the last third of the seventh century, and are therefore later than the earlier sceats. They are all, however, marked with the name of the king who issued them, in Anglo-Saxon letters (thus we have the name of Ecgfridh,* who reigned from 670-685, on No. 20, a copper coin). About the end of the eighth century the variety in design disappears, and practically all the coins are struck in copper. These copper pieces are known as stycas (the same word as the German Stück). The use of copper in the place of silver north of the Humber has been explained by the existence of vast quantities of Roman copper coins in this district. Another remarkable change is the introduction of moneyers' names, which now regularly appear on the coins. Thus the coin of Eanred here illustrated (No. 21) has on its reverse the name of PINTRED (*i.e.* Wintred) the moneyer. This modification is due to the influence of the more advanced coinage south of the Humber. But the full effect of the southern coinage was not felt until the time of the Danish kings of Northumbria.

The coinage of Northumbria during this period comprises not only a regal series, but an interesting series struck by the Archbishops of York, and corresponding in significance to the coins of the Archbishops of Canterbury with which we shall deal in a later passage. These coins (which begin about the same time as the regal series) are nearly all copper stycas. The piece given here (No. 22) was struck under Eanbald II. (Archbishop A.D. 796-808?) and reads on the obverse EANBALD AREP. The second word is an abbreviation of Ar(chi)ep(iscopus). On the reverse is the moneyer's name EADVVLF (for

* KNOWLEDGE, November 1st, 1895, No. 23.

† Sceat = treasure.

* For purposes of convenience, I represent the three Runic letters which survived into English by w (for the wen), th (for the thorn), and dh (for the corresponding soft sound).

XUM

Eardwulf). The legend on each side is preceded by a cross, and this is a very usual practice on all coins of the middle ages. The most interesting piece in this archiepiscopal series is, however, the gold solidus (No. 23) struck by Wigmund (A.D. 837-854 ?). It reads on the obverse VIGMVNDAREP, and presents a (conventional) portrait of the archbishop, with tonsured crown. The reverse reads MVNVS DIVINVM ("An offering to God"?). The occurrence at such a date of a full-faced bust on coins struck north of the Alps, or of a bust of any kind in Northumbria, is exceedingly rare.

Keary* bridges the gap between the series which we have described and the penny coinage which succeeds them by means of a transition piece (No. 24), which he ascribes to Beonna, perhaps an East Anglian king. In fabric and weight this coin stands nearer to the sceat series, but in design and style of inscription it must be ranked with the pennies. The inscription on the obverse is partly in Runic letters, and equivalent to BEONNA REX; the name of the moneyer is EFE.

The introduction of the silver penny was one of the most far-reaching changes in the history of English coinage; and this change was due to a similar change in the coinage on the other side of the Channel. The denier was introduced in France by Pepin the Short about 755. The transition piece described above is dated by Keary about 760.† The earliest pennies certainly attributable to any king are those of Offa, King of Mercia (757-796). Some time after 760, therefore, it is probable that this great innovation was made. The penny coinage was, however, not adopted in Northumbria until a century later. For nearly five centuries henceforth there was no real change in the English coinage, the silver penny being the only currency.‡

The weight of the denier when first introduced was about 19 grains troy, but in twenty years it had risen to 23·6 grains. The English pennies began lower, and rose in time to about the same average weight, though they are occasionally in excess of the weight of 24 grains which, from its connection with the silver penny, came to be known as the "pennyweight."

Offa's coinage presents a remarkable variety of types. The commonest are the conventional bust of the king, and a cross in some form or other. The name of the moneyer on the first piece given here (No. 25) is meant for Eadhun or Eadmund. The second piece (No. 26, reading OFFA REX and BAHHARD, *i.e.*, Bannard) is one of the many pieces from which the king's bust is absent.

The coins of Offa are artistically quite the best produced in England during all the period which we have to consider in this article. The money of his successors does not show the same variety of types and skill in workmanship.§ As to the origin of these types, some of them are doubtless due to native ingenuity; others are copied from the deniers of France, others from sceats, and others again from Roman coins (for at this time Roman gold coins were still in wide circulation).

It will be most convenient to divide the history of the coinage, from the introduction of the penny up to the point at which the present article is to stop, into two main periods: (1) the history of the various kingdoms up to the unification of England; (2) thence to the Norman Conquest.

The first period is one of considerable political confusion, but the state of the country had not so disastrous an effect on the coinage as it had, for instance, in later times under Stephen. The coins are fairly legible and neat. We may divide them into two series: a regal and an ecclesiastical or semi-ecclesiastical. The regal series naturally divides itself into the coinages of the various kingdoms: Kent, East Anglia, Northumbria, Mercia, and Wessex. Of these the first had ceased to be important while the anonymous sceats were still the only coinage.

The last King of Kent, Baldred, was deposed by Ecgbeorht of Wessex in 825. The coin given here (No. 27) reads BELDRED REX CAN (*i.e.*, Baldred, King of Kent) on the obverse, and OBA (*i.e.*, the moneyer's name) on the reverse.

The coinage of East Anglia may be illustrated (in addition to the piece of Beonna described above) by a coin of Æthelberht (No. 28), who was killed in 794. The name of the king is partly in Runic letters; the reverse bears the title REX and a type copied from the wolf and twins so common on the Roman coinage. This penny is, however, quite exceptional; the later pieces belong to the usual kind.

Of the Northumbrian penny series, which begins with the invasion of the "great army" in 866, we may describe a halfpenny struck by Siefred (894 to about 898) at York. (No. 29; obverse RSIEVERT; reverse EBIAICECIVI. The spelling EBRAICE CIVI(tas) corresponds to the form EBORACVM by which the Romans represented the British name which, through the form Eoferwic, has come down to us as York.) The halfpenny and farthing were also sometimes produced (less frequently at this time than later) by simply cutting the coin into halves and quarters, a process to which their thinness and frequently their cruciform types specially adapted them. We have already described some specimens of the earliest Mercian pennies, and we may therefore pass to the kingdom of Wessex. The greatness of this kingdom began with the battle of Ellandune, in 825, in which Ecgbeorht defeated Beornwulf, King of Mercia. On this soon followed the acknowledgment, more or less formal, of Ecgbeorht's supremacy on the part of East Anglia and even Northumbria. Kent was entirely absorbed in Wessex, with curious results as regards the coinage of the latter kingdom; for it appears that the coinage of Ecgbeorht is really a Kentish coinage, issued very largely either in Kent itself or by Kentish moneyers. A series of coins of Ecgbeorht exists with a monogram generally explained as that of the Latin name of Canterbury (*Dorobernia*). There are, however, coins with the legend SAX or SAXONIORVM, which most probably are of pure West Saxon origin; and the coinage of Mercia had also considerable influence on that of its conqueror. In this connection two most important coins, discovered within the last few years, must be mentioned. The first (No. 30) has the obverse legend ECGBERHT REX M, *i.e.*, King of the Mercians; and on the reverse LVNDONIA CIVIT This is the first instance of the appearance of London as a mint on English pennies. On the second, which gives the king the same title, we have the name of the moneyer Redmund, who is otherwise associated with Wiglaf, the Mercian king deposed by Ecgbeorht some time after the battle of Ellandune. These two coins are therefore interesting illustrations of the beginning of the rise of Wessex.

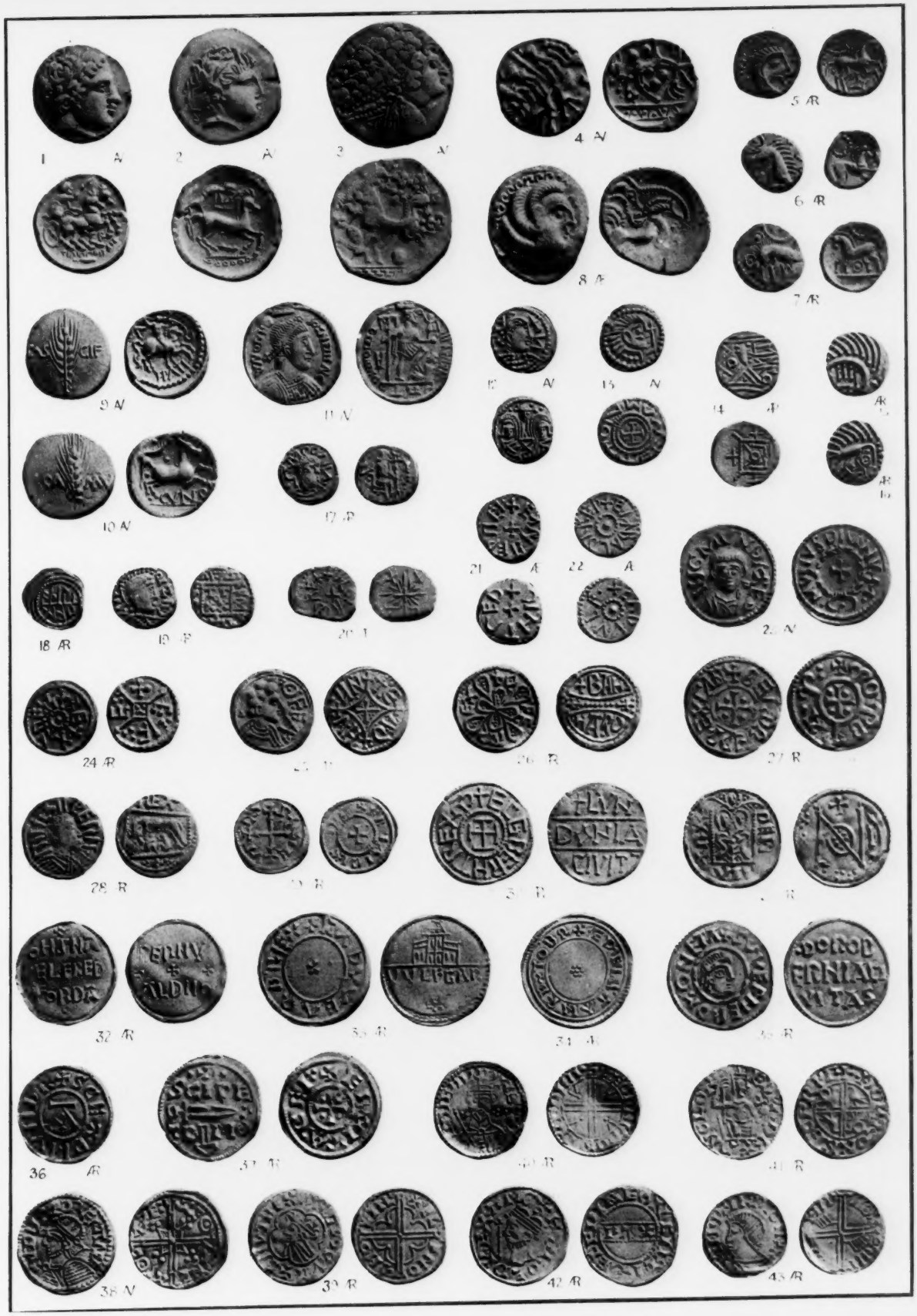
After the establishment of the West Saxon supremacy, the chief element in English history is supplied by the great invasions from across the North Sea. Into the

* Introduction to Vol. I of the "Catalogue of English Coins in the British Museum," p. xxiii. I must here acknowledge my constant indebtedness to the introductions to Vols. I. and II. of the English Catalogue.

† A Beorna is mentioned by Florence of Worcester in 758

‡ Apparent exceptions will be dealt with as they occur.

§ The heads on some of the coins of Offa are so good that one is almost justified in calling them portraits.



BRITISH AND ENGLISH COINS

history of this period it is impossible to go in detail here, and we can only briefly instance coins of a few of the better known rulers of the time.

In 874 the Viking army under Halfdan deposed Burgred, King of Mercia, and England was now practically divided between Wessex and the Danish power. One of the most remarkable coins issued by the invaders is the penny of Halfdan, when he was in London after the deposition of Burgred. The obverse type (No. 31) is similar to that of the reverse of the gold sceat described above (No. 12),* while the reverse bears the monogram of London.

Ælfred the Great succeeded to the throne of Wessex in 871, and reigned till 901. By 878 (when he won the victory of Æthandune) he had succeeded in getting rid of the Danes from England west of Watling Street and the Lea, and consolidating his kingdom; his coins probably date from after this year.

The following penny (No. 32) was struck at Oxford: obverse, ÆLFRED OHSNAFORDA (for ORSNAFORDA); reverse, BERNVALD MO (for MONETARIVS, moneyer). Under Eadweard the Elder, who succeeded Ælfred, we find a great variety of types, including one which may be meant for Canterbury Cathedral (No. 33). The workmanship of the coins of this king is neater than any since the time of Offa, and there seems to have been some attempt at portraiture. Eadweard's successor, Æthelstan, also struck a fine series of coins, but of less varied types. The number of mints (the names of which it had become not unusual to place on the coins in the time of Ælfred) begins to increase in this reign, and the new places from which coins were issued are evidence of the steps by which England was gradually recovered from the Danes. Æthelstan sometimes calls himself King of all Britain (REX TO BR on No. 34). From this time to the reign of Eadgar (959-975) there is no important change in the coinage to be chronicled.

We may now, before passing to the coinage of unified England, look briefly at some of the exceptional issues of the period just described. Beginning with the archiepiscopal coinage, we illustrate (No. 35) a coin struck at Canterbury in 832-833 during the interval between the death of Wulfred and the appointment of Ceolnodh. On the obverse is a head to the right and the name of the MONETArius SVVEFNERD; on the reverse DOROBERNIA CIVITAS. The coins struck by the archbishops themselves are not of any unusual interest; but there are at least two remarkable series of quasi-ecclesiastical coins which must be mentioned here. These are the memorial pennies of St. Eadmund, struck in East Anglia chiefly during the end of the ninth century, and a somewhat similar series with the name of St. Peter, struck probably about the middle of the tenth century. The former series is represented here (No. 36) by a coin which reads SC (*i.e.*, Sanctus) EADMVND R on both sides, but the reverses are more commonly occupied by moneyers' names, sometimes of a very strange character. Most of them appear to be Frankish, and the coins may have been issued by Frankish traders settled in the district. The St. Peter coins were struck at York during the Danish occupation, and probably under the direction of the archbishops. The type of the obverse of the coin figured (No. 37) is a sword, the legend SCI PETR MO, *i.e.*, Money of St. Peter. These coins have of course no connection with the Peter's Pence, which were a tribute paid into the Papal Treasury on St. Peter Mass. The other subsidiary coinages of this period we must pass over unnoticed.

Under Eadgar, the first King of all England, there is a great increase in the number of mints, but otherwise nothing remarkable to chronicle. Æthelred II., the Unready (*i.e.*, devoid of counsel), issued a very large number of coins, in spite of the distressful state of his kingdom. He is occasionally represented wearing a helmet (sometimes combined with a crown). The combination is seen on the gold piece here illustrated (No. 38), which was made at Lewes (LÆPE) by the moneyer Leofwine (LEOFPINE). This piece is usually regarded as a proof or pattern; but it may equally well have been struck as an offering penny or presentation piece. A similar gold piece of Edward the Confessor exists. This coin also gives us an instance of the double cross, which now becomes common, owing probably to its convenience with a view to cutting the penny into halfpennies or farthings.

During the reign of Æthelred II. the English coinage had an enormous circulation all over the Scandinavian world, and the later coinage of these parts was modelled on the English money. The English coinage presumably travelled abroad as ransom or plunder, though, did we not know the facts, we should naturally conclude from the numismatic evidence that Æthelred's reign was one of great prosperity.

The remaining rulers of England previous to the Norman Conquest must be briefly dismissed. Under Cnut we notice the occurrence of the crowned bust (No. 39, reading CNVT REX ANGLORVM and ÆLFNOD MO LINC, a Lincoln penny, therefore), which Cnut adopted from the German emperors. The legend PACX (common enough on later coins) now first occurs on some of Cnut's coins, having reference probably to the peaceful settlement of English affairs in 1017-18. Cnut also sometimes wears a pointed helmet, like that found on the Bayeux tapestry.

Passing over Harold I. and Harthacnut we come to Edward the Confessor. In this reign two interesting types are introduced. The king is sometimes represented seated, holding sceptre and orb surmounted by cross—the symbols of sovereignty. (No. 41, EDPAD RX ANGLOR and DORR ONN EOFRPC, *i.e.*, Dhorr at York.* On the reverse are four martlets in the angles of the cross, generally supposed to be the heraldic device of the king, though there is doubt as to their true character.) Another new type, so far as the regal series is concerned, is the facing bust, which occurs, *e.g.*, on the coin struck at Cricklade (No. 40, LEOFRED ON CRECLA).

We close the English series with a coin of Harold II., who seems to have adopted only one type. The coin we give (No. 42) was struck at Chichester, and reads HAROLD REX ANG and ÆLFPINE ON CICEI, with the legend PAX in the centre of the reverse.

The Scottish coinage does not commence till the reign of David I. (1124), nor the Irish until the period of the second Scandinavian invasion of England, at the end of the tenth century. At that time we find a number of coins bearing the names of Æthelred II. and Cnut. These were only imitative coins, and do not imply that these kings ruled in Ireland. They preceded the coinage of the Norseman Sihtric, who reigned in Ireland, dying in 1042. His silver pennies (No. 43) are copied from those of Æthelred II.; the objects in the two angles of the cross are probably meant for hands. The name of Sihtric is generally more or less blundered. From this period till the time of the English conquest, under Henry II., there is no Irish coinage.

* It also occurs on coins of Ceolwulf II. of Mercia (who was set up by the Danes in 874) and of Ælfred the Great.

* ON or ONN has been explained as a corruption of MON, but this is improbable.

SOME CURIOUS FACTS IN PLANT DISTRIBUTION.—II.

By W. Botting Hemsley, F.R.S.

Some particulars have already been given of the composition of the vegetation of several of the remote islands in the highest southern insular limits of flowering plants, especially in relation to its general poverty, the absence of shrubby plants, and the extreme rarity of conspicuous and brightly-coloured flowers. Proceeding northward from Macquarie Island, in the New Zealand region, the climatic conditions are rapidly less rigorous; a few degrees of latitude bringing considerable change, and a corresponding increase in the variety and character of the plants constituting the vegetation. This is exemplified in Campbell Island, in about 52° 30′ latitude, and still more in the Auckland group, two degrees further north. On the windward side of these islands the vegetation is poor and stunted; but on the leeward side, and in the sheltered valleys, there is a comparatively rich and varied flora. There are no very large trees, it is true, but small trees and shrubs abound. The commonest, largest, and most conspicuous tree is *Metrosideros lucida* (myrtaceæ), which attains a height of twenty to forty feet, with a trunk occasionally as much as three feet in diameter. It bears showy crimson flowers, and is a very striking object in the landscape. *Dracophyllum*, a genus of the heath family, having leaves much like those of a *Dracæna* or a small screw-pine, is represented by two arboreous species, totally unlike anything in north temperate regions, and no less striking than the myrtle just mentioned. *Veronica elliptica* is another small tree inhabiting these islands. Most of our northern species of *Veronica* are herbs or quite low shrubs; whereas in the New Zealand region, where the species are much more numerous and varied than in any other part of the world, they are nearly all shrubby. *V. elliptica* is the only really arboreous species, sometimes growing as much as thirty feet high, and when covered with its bright blue flowers it is a beautiful sight. It is also still more remarkable that this tree is found in the South American region, growing as far south as Hermite Island (lat. 55° 52′), Fuegia, within three latitudinal minutes of Cape Horn. This, I should explain, is a somewhat higher latitude than the remote islands whose vegetation I have described as the highest southern latitudes where flowering plants exist at the present time. I should have added, in remote islands. Among the shrubs of the Auckland Islands flora are many bearing showy berries; and the herbaceous element includes handsome plants of the aster, orchid, lily, and other families. There are also some very robust and ornamental pink-flowered umbelliferæ, allied to our *Angelica*. Ferns abound, too; but the characteristic beech-trees and conifers of the New Zealand mainland are wholly wanting.

Proceeding no farther northward than Stewart Island (47° lat.), in the extreme south of New Zealand proper, we encounter a subtropical vegetation, in which tree ferns and trees having brilliantly coloured flowers are conspicuous features. This island, having an area of only six hundred and forty square miles, and altitudes up to three thousand feet, is still imperfectly explored; yet no fewer than three hundred and eighty species of flowering plants and seventy species of ferns have been discovered within its narrow limits. I must not dwell on the attractions of this rich southern flora, which owes its wealth to a combination of local conditions. Taken as a whole, however, the flora of New Zealand is poor in generic forms; such familiar and wide-spread genera as *Ranunculus*, *Epilobium*, *Senecio Veronica*, and *Carex* contributing very largely to the total number of species, nearly all of which are endemic or restricted to the islands. The relatively numerous endemic genera are mostly represented by one or few species, and present many interesting phenomena in plant distribution which I cannot attempt to discuss or explain here. I may add that, with the exception of Stewart Island, all the small islands referred to are uninhabited.

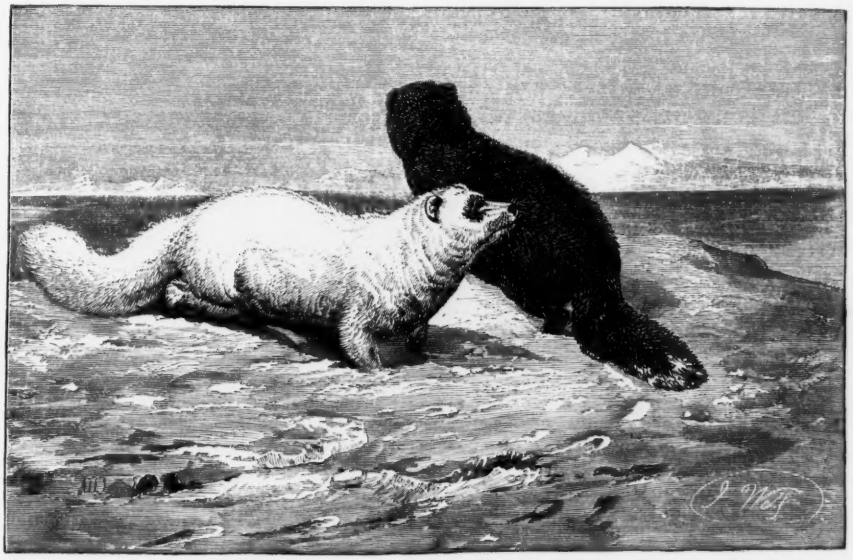
I will now invite the reader to accompany me, in imagination, to some groups of uninhabited islands in the southern part of the Indian Ocean, midway between Macquarie Island to the east and South Georgia to the west, but in somewhat lower latitudes, ranging from about forty-seven degrees to fifty-three degrees south. These are the Prince Edward group and Crozets, corresponding in southern latitude to the centre of France in the north; and Kerguelen and the Macdonald group, corresponding to Cornwall and Nottingham respectively. A glance at the map will teach more than many words the distances these groups of small islands are from each other and from the nearest continents. With the exception of Kerguelen, which has an estimated area of a little more than two thousand square miles, these volcanic islands are all of small extent. Their vegetation is of the scantiest, and its composition is nearly the same throughout, except that Kerguelen has twice as many species as any of the other islands or groups of islands.

The climate is not very severe and the range of temperature is not great; yet the nature of the climate is unfavourable to vegetation. In Kerguelen, for example, the thermometer rarely rises to 70° Fahrenheit, and rarely falls more than a few degrees below the freezing point; but it is almost continuously cold, bleak, and stormy, due to these islands being in the track of the Antarctic currents, Heard Island, in the Macdonald group, is still in a glacial period, with glaciers almost down to high-water mark. This island is about twenty-five miles in length by six in its greatest breadth, with mountains rising to a height of seven thousand feet. Only five species of flowering plants have been collected there, and the same number in the Crozets, with two ferns added; fourteen of flowering plants and ferns combined in Marion Island, Prince Edward group; and twenty-seven in Kerguelen. Not one is of a woody nature, but fossil wood discovered in Kerguelen affords evidence of the existence of forests at some probably very remote period. Six species out of an aggregate of thirty have not been found elsewhere. One of these, the Kerguelen "cabbage" (*Pringlea antiscorbutica*), is specially deserving of notice, both on account of its history and its value as a pot-herb or salad. Captain Cook, although not the discoverer of the island, was the co-discoverer of the cabbage, and took great interest in it in connection with its antiscorbutic properties. Cook was keenly alive to the ravages of scurvy among seamen, especially those engaged on long voyages, away from civilized countries; and, through the precautions he took, he was very successful in combatting this dreadful disease.

But in the narrative of the voyage it is William Anderson, surgeon and naturalist to the expedition, who is quoted on the vegetation of Kerguelen, and he says: "Perhaps no place hitherto discovered in either hemisphere on the same parallel of latitude affords so scanty a field for the naturalist as this barren spot." He then goes on to describe, in a general way, the principal plants, including the cabbage, and places the total number of species at about eighteen. He also mentions that they ate the cabbage both raw and

cooked. This was in 1776, and it was left to the now veteran Sir Joseph Hooker, who accompanied Sir James Ross on his memorable Antarctic expedition, 1839 to 1843, to publish a full and illustrated account of this remarkable plant, partly from his own experience and observations and partly from Anderson's manuscript in the British Museum. The name *Pringlea* he adopted from Anderson, who proposed it to commemorate the name of Sir John Pringle, who wrote a treatise on scurvy, which is appended to the account of Cook's first voyage.

This plant is the largest and the most abundant in Kerguelen, growing most luxuriantly, however, on the sea-shore, where it is the first to greet the grateful mariner. It belongs to the cruciferæ, the family to which belong our cabbages, cauliflowers, radishes, turnips, cress, and other valuable esculents; and it is one of the most distinct of its family, not being very closely related to any existing member. In addition to being abundant in Kerguelen, it also occurs plentifully in the Prince Edward, Crozet, and Macdonald groups, which, although uninhabited, are the resort of whalers, to whom it is a great boon and luxury. Sir Joseph Hooker states that during the three months' stay of the *Erebus* and *Terror* at Kerguelen in 1840, the native cabbage was cooked daily for the use of the officers and crew. I have written somewhat fully on this plant because of its immense utility to man in a region where there is so little vegetation, and where in the islands of the Indian Ocean in question it is the only member of the natural order which, in corresponding northern latitudes, is so numerously represented and produces such a variety of esculent vegetables.



Arctic Foxes.

OUR FUR PRODUCERS.—III.

FOXES, WOLVES, AND BEARS.

By R. LYDEKKER, B.A.Cantab., F.R.S.

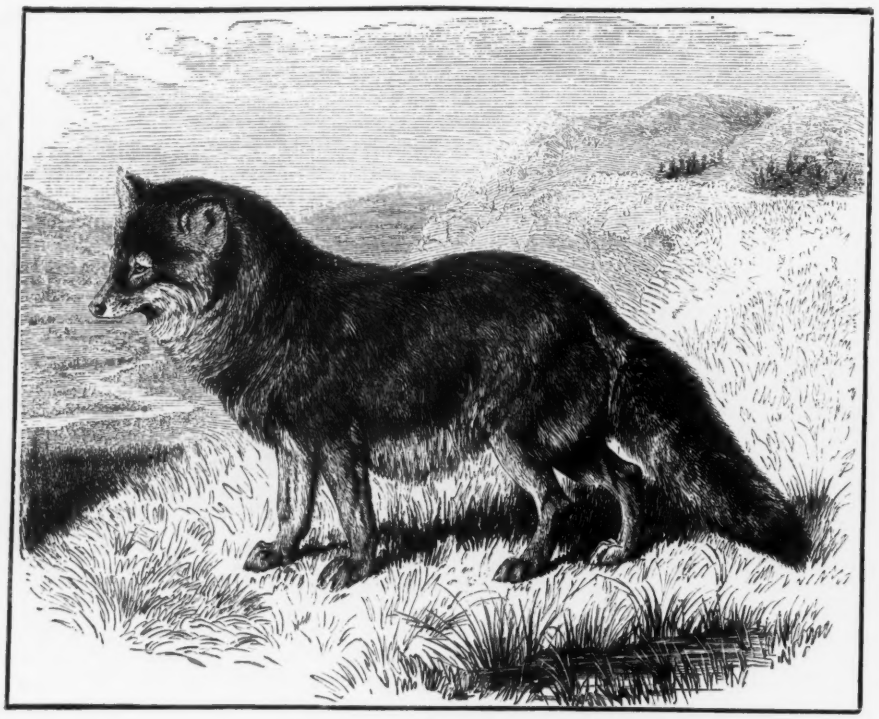
NEXT in importance to those of the weasel tribe, among the land carnivora, are the furs of the various species of wolves and foxes, the pelt of the renowned silver fox of North America realizing prices second only to those paid for skins of the sea-otter. Both foxes and wolves belong to the great dog family (*Canidæ*), and as the general appearance of all these animals is sufficiently well known to our readers there is no necessity for giving any description.

Few mammals are subject to greater variation in colouration than the ordinary fox (*Canis vulpes*); and hence it happens that whereas this animal is really a very widely spread one, with numerous local varieties, it has been split up into a host of nominal species, such as the cross fox, silver fox, Himalayan fox, and Nile fox. Wiser counsels fortunately, however, now obtain, and (among European naturalists at any rate) these and other varieties are reckoned merely as peculiarly coloured races of the common fox. Even in England there is a certain amount of variability in this widely-spread species, examples being sometimes killed in which the characteristic white tip to the "brush" is wanting; while one has been caught with the under parts as dark as in the Italian race. In the latter instance it is, however, of course possible that the animal may have been a foreign "bagman" imported into this country.

The descriptions of all the colour variations to which the fox is subject are far too long to be even referred to here, and belong more properly to a work on natural history; and we shall consequently confine our notice, in the main, to the prices and numbers of the different varieties of pelts that come into the market. As the most expensive and most beautiful of all, the North American silver fox claims our first attention. With the exception of the tail-tip, this variety is almost entirely black, the hair on the hinder part of the back, outsides of the thighs, and head being ringed with grey; but some examples are wholly black and others wholly grey. It is now a comparatively scarce animal; but about five-and-forty years since it was sometimes seen in the mountains of Pennsylvania and the wilder districts of New York State. The American Fur Company obtained most of its skins from the Upper Mississippi and the districts to the north-west of the Missouri River. From about one thousand five hundred to two thousand skins are annually sold in London. Of these, the pale-coloured varieties realize only from some five to eight pounds apiece; but even in 1890 fine black skins sold at from fifty pounds to seventy-two pounds. In 1894 the price went up to an extraordinary degree, and many skins were sold at more than one hundred pounds. The highest price was, however, realized at a sale in London in the spring of 1895, when an unusually fine skin sold at no less a figure than one hundred and seventy-five pounds. The pelts, which are

usually made up into muffs and trimmings, are chiefly bought by the French and Russians; the most costly of all furs finding their way to Russia.

Next in scarcity of the American varieties is the so-called cross fox, taking its name from the transverse band of darker hair across the shoulders; the under surface of the body and legs being black. Ordinary skins of this variety sell at from one pound to two pounds ten shillings; but unusually dark-coloured specimens vary in price from five pounds to seven pounds each. According to Mr. Poland, the number of pelts that come annually into the London market oscillates between five and seven thousand. The commonest of all in America is the red fox, in which the general colour is reddish yellow, becoming grizzled on the hinder part of the back. Probably the Kamschatkan fox is identical with this variety. The trade in American red fox skins is enormous, from seventy to ninety thousand being yearly sold in London, at prices varying from two to sixteen shillings each. In the earlier part of the century the value was, however, considerably greater. Mr. Poland states that "red fox skins are mostly purchased for export to Russia, Turkey, Greece, Servia, Bulgaria, and other Eastern countries, where they are used for trimmings, coats, etc."



The Coyote.

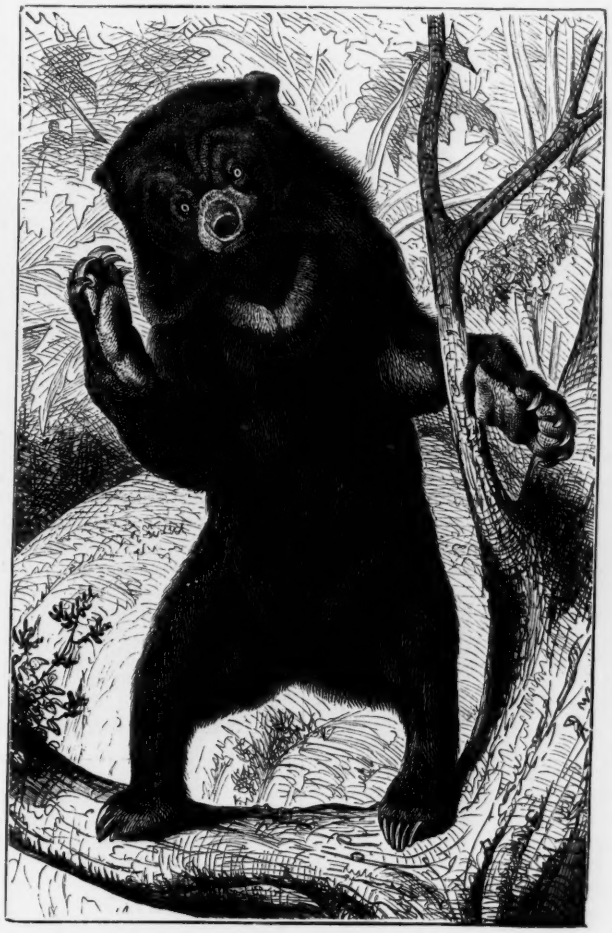
Although in Britain but few pelts of the European fox are saved, on the Continent there is a very large trade in them, about one hundred and thirty thousand being sold annually at Leipsic, and some two hundred thousand at the Irbit Fair in Siberia; while the number collected yearly in Germany is stated to reach about half a million. Average specimens sell at about two shillings.

There is a considerable trade in the skins of the Oriental foxes, although it is far from easy to determine which species yields the maximum supply. Probably, however, the greater number are the product of the Himalayan fox, the so-called *Canis montanus*, which is, however, only another variety of the common species. This form has black under-parts, and not unfrequently a dark cross mark on the shoulders. It is found from Afghanistan throughout the Himalaya. Skins vary in value from eighteen pence to three shillings each; and it is stated that several thousands are imported to Leipsic by way of Arabia, in addition to about a hundred thousand through Nishin. In Kashmir and Cabul these skins sell at about nine annas each; and when a number are sewn together they form a very warm and handsome carriage rug. Although the fur of the small Indian desert fox (*C. leucopus*)—with which the Persian *C. persicus* is probably identical—is short and of but little value, a small number of skins are exported every year from Karachi.

Very distinct from all the other members of the group is the Arctic fox (*C. lagopus*); also known either as the blue or the white fox, according as to whether it is in the summer or the winter coat. From other foxes this species differs by having the soles of the feet thickly clothed with hair, while it is further characterized by the bushiness of the tail. Some writers appear to be in doubt whether a blue fox turns white in winter, but that this is the case is certain. In the summer the general hue of the fur is bluish, or occasionally brownish grey. Dr. Mivart writes that the change from grey to white "does not, by any means, invariably take place, even in this species. Individuals seem often to be met with in their native haunts with their summer dress in winter, while others remain entirely white the whole year round." Although inhabiting all lands within the Arctic Circle, this fox extends a considerable distance south of the latter in both hemispheres, but more so in the Eastern than in the Western. The white winter skins vary considerably in quality, those from Alaska and Siberia being coarse-haired, whereas Greenland and Labrador samples are finer. From Siberia it is stated that between twenty and sixty thousand skins are imported into Europe, most of them being sold at the fairs of Irbit and Leipsic; while about nine thousand came to hand in 1891 through the Hudson Bay and Alaska Fur Companies, and nearly a thousand were obtained from Greenland by a Danish company. The price per skin varies from half a crown to about sixteen shillings and sixpence. Blue fox is much more valuable, the prices varying from about a pound to as much as fourteen or even fifteen pounds per skin. A certain number of pelts are

obtained from Iceland, where the species retains its "blue" tint throughout the year; but the entire out-turn is comparatively small, the number exported by the American companies in 1891 being a little over three thousand, while in the same year the Danish company accounted for about one thousand four hundred. In the Pribylov Islands the Arctic fox subsists chiefly upon young seals and sea-birds and their eggs. The white skins are largely employed in the natural condition for wrappers and rugs; and when dyed black or brown are manufactured into muffs or used for trimmings, in imitation of silver fox. The tails are also made up into boas.

Of the other foxes the one of most commercial importance is the Virginian, or grey fox, of North America (*C. virginianus*), taking its name from the general dark grey hue of the fur. Mr. Poland states that in 1891 over twenty-five thousand grey fox skins came into the London market, which realized from sixpence to four and sixpence each. This, however, is one of the furs that of late years has gone out of fashion, since considerably higher prices were formerly paid. In habits the grey fox differs considerably from the common species, as when hunted it always runs in a circle, instead of in a straight line, and when hard pressed will not unfrequently seek refuge by running up the stem of some sloping tree. In spite of its soft and thick fur, the smaller American kit fox (*C. velox*), characterized by the light grey colour of the back, the yellowish flanks, and the white under-parts, is of still less importance from a commercial point. But few skins now come into the market, and these realize only from eightpence to a little over two shillings each. Although sometimes dyed black they are chiefly employed, for the cheaper kinds of fur wraps.



Malayan Bear.

Of the South African forms, the only one of which skins come into the market appears to be the asse fox (*C. chama*), which is a somewhat long-eared species, intermediate in character between the typical foxes and those small very long-eared forms known as "fennecs." Even of this species only a few skins are imported into Europe, and there appears to be no regular price quoted. In parts of South Africa its skins are used by the natives for making their cloaks or karosses.

South America is the home of several small species of the genus *Canis* commonly spoken of by the English settlers in that country as foxes. They differ, however, from the true foxes in several characters of the skull, and belong to a different group of the genus. Although they have in general good fur, but very few skins find their way into Europe, and such as do so sell at between one and two shillings each. Probably the majority belong to Azara's fox (*C. azaræ*), which is one of the commonest of the Argentine species.

A very remarkable member of the canine family is the so-called raccoon-dog (*C. procyonides*), from Japan and other parts of North-Eastern Asia, which derives its name from its curious superficial resemblance to a raccoon. It has long loose fur, of a general dark brownish grey colour, small ears, and a short bushy tail; the under-fur being short and very close. Although by naturalists this animal is frequently regarded as somewhat rare, the number of its skins imported for commercial purposes indicate that it must really be extremely common. According to Mr. Poland, upwards of thirteen thousand pelts were imported in 1884, and about seventy thousand in 1891; the majority of these coming from Japan. It is sold under the names of either Japanese fox, jackal, or badger; and some of the skins are received in England with the long hairs removed and only the short under-fur remaining. From fourpence to seven shillings and sixpence each appears to be the range in the value of the pelts of this species, the price fluctuating both with the quality of the skins and the demand for them. This fur, which is used both dyed and of the natural colour, is made up into trimmings or capes.

The jackals, which are intermediate in point of size, and in some respects also in external character, between the true foxes and the wolves (although differing from the former and resembling the latter in the structure of their skulls), are of little or no commercial importance. This is not to be wondered at in the case of the common jackal (*C. aureus*) of South-Eastern Europe, Western Asia, and Northern Africa, seeing that its fur is harsh and little suited to the purposes of the furrier. Consequently the pelts of thousands of these animals annually destroyed in Algeria are wasted. It seems, however, a pity that the fur of the handsome black-backed jackal (*C. mesomelas*) of Central and South Africa is not made more use of, seeing that the difference in colour between the black of the back and tail, flecked with

silvery grey, and the bright tawny of the flanks, head, and limbs, forms a striking and pleasing contrast. Only a few skins appear to be imported, which average about three shillings in price, and are chiefly employed for fur wraps. We cannot find that the pelt of the side-streaked jackal (*C. adustus*), which is likewise an African species, is ever used at all.

Of more importance are the wolves, of which some of the skins are very handsome, and command a considerable price in the fur market. As in the case of the common fox, we here again once more meet with the difficulty of deciding what degree of difference constitutes a species, and what ought to be reckoned as a mere variety. It is, however, now generally conceded that the North American wolf is not specifically distinct from its European and Asiatic cousin (*Canis lupus*), and that the dark-coloured woolly wolf (*C. laniger*) of the highlands of Tibet is likewise only a local race of the same. Probably also the so-called blue wolf (*C. hodophylax*) of Japan comes under the same category; but there is some difference of opinion with regard to the Indian wolf (*C. pallipes*). Including all these, save the last, under the head of the common species, we may have grey, brown, black, white, yellow, and "blue" wolves; long-haired and short-haired wolves; and wolves with a thick woolly under-fur, as well as others in which there is scarcely any under-fur at all. The greater portion of the European supply of wolf pelts comes from Siberia, whence several thousand annually find their way to the markets of the South; a few hundred also coming from China. From America less than a thousand skins come yearly to England; the grey samples, according to Mr. Poland, selling at from four to twenty-four shillings, the white at from seven and sixpence to four pounds ten shillings, and the blue at from two pounds ten shillings to six pounds each. There appear to be no quotations for black Tibetan wolf skins—doubtless on account of their rarity—but Chinese pelts average about sixteen shillings. Wolf skins are especially used for wrappers and carriage and sleigh rugs; while, when dyed black or brown, they are made up into boas, for which purpose they are specially suited on account of the unusual lightness of the skin. The skin of the Indian wolf would probably be valueless, on account of the absence of under-fur.

Whatever question there may be as to the right of the latter to specific separation from the ordinary wolf, there can be none with regard to the so-called prairie wolf or coyote (*Canis latrans*) of the United States and Canada. It is a considerably smaller animal, with the fur generally grey or grizzled, and the tail-tip usually black. Although the long and thick fur is somewhat harsh, skins of the coyote form an article of some importance in the trade, but we have been unable to ascertain their price. Probably from four thousand to six thousand pelts come annually into the market, which are used both for rugs and boas, in the latter case being generally dyed black or brown. From its extreme wariness the coyote is one of the most difficult of North American fur-bearing animals to trap. Of the small Falkland Island wolf (*C. antarcticus*)—the sole South American representative of the wolves—it is stated that from fifty to a hundred skins are imported annually into this country. The fur is dark brindled, and is said to be sometimes used to imitate that of the grey fox.

Before leaving the *Canidæ* mention must be made of certain large Chinese and Siberian dogs, of which the skins appear to form a very important item in the fur trade. The Chinese dog is described as being about the size of a retriever, with a long but not bushy tail; while the Siberian dog is larger, and its black coat of a still finer texture. Of the Chinese dog, Mr. Poland states that from fifty thousand to one hundred thousand skins yearly reach the London market; but in addition to this the value of the yearly collection in Manchuria amounts to between £40,000 and £60,000 in value. Of those exported from China the bulk are made into robes of eight skins (sometimes four), and sent from Shanghai to London and New York. They vary in colour; black, white, and fawn being the predominant tints, while a few are brindled.

The amount of space taken up by the foregoing account of the foxes and wolves leaves but little room for the bears. Among these latter by far the most valuable pelts are those of the white Polar bear (*Ursus maritimus*), of which from thirty to a hundred are annually imported from Greenland to Copenhagen by a Danish company. The best of these realize from ten pounds to thirty pounds apiece; but of those imported by the Hudson Bay Company the price is much lower, owing to their bad condition. Less than a hundred is the usual annual import. The fur, which is occasionally dyed black, is made up into rugs and wraps. Naturalists are now pretty well agreed that the grizzly and black bears of North America, as well as the Isabelline bear of the Himalaya, are nothing more than local races of the European brown bear (*Ursus arctus*). Including such varieties, bear skins range in colour from pale cinnamon to black. We have been unable to come across any account of the annual number or value of European skins, but of grizzly pelts about three thousand five hundred were sold in 1891 at prices ranging to as much as seven pounds ten shillings for fine specimens. Many bears are also killed in Kamschatka, some of their skins being of enormous dimensions, as also are those obtained from Alaska. More valuable is the American black bear, of which fine skins realize as much as twelve pounds; upwards of seventeen thousand being sold in 1891. Still more precious are the pelts of the cinnamon bear of the same country, which now fetch about thirteen pounds, although they formerly sold for as much as thirty pounds. About three thousand skins came into the market in 1891. Bear skin is used for trimmings, wrappers, rugs, and boas; that of the black bear (dyed) being employed for the headpieces of the Foot Guards. The fur of the cubs of the same variety is valued for coat-collars. The Himalayan black bear (*U. torquatus*) and the Indian sloth bear (*Melursus ursinus*) have such short or coarse hair that their pelts are practically valueless.

Science Notes.

Remarkable results have been obtained in France by M. le Bon, who has been continuing his researches for some years. He finds that the light of an ordinary petroleum lamp will print a photographic positive on a dry plate through a sheet of iron, especially if the dry plate be arranged with a sheet of lead behind it, the lead being folded over round the edges of the iron. Other metals, and also cardboard, act in the same way, and it seems only to be a question of time. The name of *dark* or *invisible light* has been given to the agent concerned in these phenomena. It does not pass through black paper, and differs in this respect from the X rays of Röntgen.

In a further description of his work, Le Bon mentions experiments in which photographic effects were obtained from ordinary sources of light, the plate being screened by optically opaque bodies. It is suggested that "dark light" is a form of energy intermediate between light and electricity. It is possible that it does not act directly, but by means of phosphorescence.

In the application of the Röntgen rays to surgery in France, the shadow photography has indicated that in a case of bone disease the centre of the bone was affected, and not the periosteum. The limits of tubercular affection of bones of the hand have been ascertained, and an internal ulceration of bone, lying beneath an ulceration of the skin, has been discovered. In our own country Dr. John Macintyre, of Glasgow, has got remarkable shadow pictures of the spinal column and ribs of a man. He finds that the head is easily penetrated, and expects great things from the application of Röntgen rays to surgery when a more powerful source of these rays has been obtained.

Experiments have been made by A. M. Bleile upon dogs in order to determine the cause of death in electric shock. The conclusion reached is that for a given animal in normal condition as to health a definite amount of electrical *energy* will produce fatal results. It is thought that the action of the electrical discharge is to contract the arteries and increase the pressure of the blood, and that death is due to inability on the part of the heart to sustain the increased pressure of the blood so produced. Post-mortem examinations seem to show that the passage of the current does not cause any anatomical disintegration.

The results of the use of antitoxic serum in the treatment of diphtheria are clearly indicated by the report recently issued as to the cases in the hospitals of the Metropolitan Asylums Board. In 1894 there were 3042 cases and 902 deaths, the mortality per cent. being 29·6; in 1895 the number of cases was 3529 and the number of deaths 796, the percentage of fatal cases being 22·5. The reduction in mortality of 7·1 per cent., occurring in the second year referred to, must be attributed to antitoxin.

Observations taken during the second half of the year 1895 by Tacchini, at the observatory of the Roman College, show that during this period sunspots have continued to decrease, with a secondary minimum in November, when spotless days were observed. The protuberances have shown very little change during 1895.

Moissan in France has analysed specimens of opium as used by the Chinese, and finds that the smoke is formed of volatile perfumes and a small quantity of morphine. It is the latter which produces the phenomena sought by opium smokers, and it is said that they do not appear to find more ill effects from the practice than most tobacco-smokers, provided that they use the preparation known as *chandu* of the best quality. The commercial quality of opium is, however, very different, and the inferior sorts when decomposed by heat produce various poisonous compounds.

Some observations of the surface of the planet Mars recently made by Prof. Barnard with the Lick telescope suggest that a possible change may take place in present ideas as to what represents land and water on Mars. The so-called "seas" did not appear to consist of seas and oceans, but seemed to be exactly the reverse. They were rich in markings which are compared to the aspect of a mountainous country as seen from a great elevation. On the "continental" regions irregular features represented by delicate differences of shade were noticed, but no straight sharp lines were seen on these surfaces.

A plea for the increased use of imagination in science was put forward by Prof. R. Meldola in a presidential address recently delivered to the Entomological Society of London. That prince among experimental philosophers, Michael Faraday, used to say, "Let us encourage ourselves by a little more imagination prior to experiment"; and there is a tendency among men of science to-day to act upon his advice. Science is organized knowledge, and no mere collection of facts can constitute it. Observation and experiment are primarily essential; but we only become scientific when we compare the facts accumulated, and use the imagination to generalize them and to guess at the principles which they teach. The hypotheses thus arrived at may be, and often are, wrong; nevertheless, real progress only begins when facts are sought in relation to at least the suggestion of a principle.

Mark how extremely fruitful has been the late Mr. H. W. Bates' explanation of the phenomena of mimicry and protective resemblance among butterflies and moths. While pondering over the meaning of the remarkable superficial resemblances among the butterflies of different groups which he had collected in the Amazon Valley, it occurred to him that the resemblance might be a real advantage in some cases. There is, for instance, a beautiful group of butterflies (the Heliconii) in the South American forests, which, though they possess conspicuous colouration and fly slowly and weakly, are not eaten by birds, and are therefore very abundant. The reason they enjoy immunity from birds appears to be that they possess a strong and offensive odour, which is probably combined with a nauseous flavour. But the curious thing is that certain butterflies of groups which are not characterized by these disagreeable attributes, are coloured in much the same way as their less edible companions, so as to be commonly mistaken for them.

Mr. Bates pointed out the protection from foes afforded by such resemblances as these, and speculated on the importance of adaptive colouration in the preservation of species. The explanation which he suggested as the cause of the phenomena gave vitality to what would otherwise have been a disconnected and meaningless set of facts; it prompted further observation and experiment, and has resulted in the accumulation of many new instances of the same principle. The history of science furnishes numerous similar cases where the use of the imagination has stimulated enquiry and made for scientific progress, though few investigators recognize them. The growth of a broader feeling has, however, lately shown itself; to which statement Prof. Meldola's remark, that "the philosophic faculty is quite as powerful an agent in the advancement of science as the gift of acquiring new knowledge by observation and experiment," will bear witness.

VARIABLE STARS.

By Dr. A. Brester Jz.

SINCE writing my article on red variables and Novæ,* two remarkable investigations have been published which are of the greatest importance for the development of my theory, and especially in the case of variable stars.

I have first to mention Mr. Alex. W. Roberts' study of "close binary systems" in the November Number of the

* *See* KNOWLEDGE, December, 1895. The results of Messrs. Jewell, Humphreys, and Mohler's investigations as to the effect of pressure on the displacements of spectral lines give a new support to my theory that the compound spectrum of a Nova does not prove that it is caused by two oppositely moving bodies. Such a spectrum is much more easily explained, I think, by the great differences in depths and corresponding pressures at which the bright and dark lines originate. (*Astrophysical Journal*, February, 1896.)

XUM

Astrophysical Journal. Mr. Roberts has chiefly investigated δ Cephei as a good example of a short-period variable of constant variation.

Now we know, since M. Belopolsky's researches, that in the case of δ Cephei its variation is intimately connected with a revolution in a very elliptical orbit. But as all trustworthy observers of this star bear testimony of the continuous waxing or waning of its light, every eclipse theory of variation must be rejected. This theory would also be inconsistent, as Mr. Roberts shows, with the position of the maximum and minimum phases. Apart from eclipses, there must be, therefore, another phenomenon able to cause variability in close binary systems.

That phenomenon, according to Mr. Roberts, is the increase of heat at periastron, the heat falling upon the companion being then in the orbit of δ Cephei nine times greater than at apastron. Mr. Roberts supposes that this greater heat near periastron causes the two stars to be brightened up by an increase of temperature, the subsequent cooling near apastron being the cause of the minimum. But that explanation cannot be granted if the two stars have some analogy with our sun. A sun cannot rise or fall one or two magnitudes by changes of temperature in the space of three days.

But the brightening by periastric heat and darkening by apastric cooling can be easily understood if we assume that one of the two stars is a red star with an obscuring cloudy atmospheric veil, alternately dissipated by the greater heat near periastron and slowly recondensed again by the subsequent cooling near apastron. Thus, near periastron both stars would be visible, and near apastron (at least clearly) only one. There, as well as in other red variables, the change of brightness would be caused precisely as the darkening of our sun is caused by even the smallest clouds in our sky. If the hypothesis of Mr. Roberts is thus amended it fits admirably well in my theory, as will be seen in the following

Classification of Variables.

Cl. A.—*More or less irregular Red Variables and Novæ.*—Single stars internally always red, but covered by cloudy atmospheric veils, alternately growing thicker by cooling and then again dissipating by heat, which, due to the intermittent formation of chemical compounds, is also produced by cooling. Besides the somewhat capricious changes of brightness thus caused (always attended with a bright luminescence of the condensing atmosphere), symptoms of a more regular periodicity can be expected if phenomena analogous to those in the Classes B and C are also working here.

Cl. B.—*Regular Variables with continuous variation.*—Close binaries with very eccentric orbits. One of the stars is a red star with a cloudy atmospheric veil (as in Cl. A). This veil is dissipated by the greater heat when the stars are closest, and re-condenses by the subsequent cooling near apastron.

a. The plane of the orbit does not pass through the earth (δ Cephei, X Sagittarii, T Vulpeculæ, etc., etc.).

b. The plane of the orbit passes through the earth. Apart from the periastric and apastric maxima and minima, secondary minima are produced by eclipses (η Aquilæ, R Sagittæ, β Lyræ).

Cl. C.—*Regular Variables remaining invariably bright for most of the time, with minima of short duration.*—Close binaries revolving fast in orbits whose planes pass through the earth, and where eclipses of short duration are the only cause of the variation.

a. The binary consist of a bright and a dark star (Algol).

b. The binary consist of two equally bright stars (Y Cygni).

c. The binary consist of two differently bright stars (Z Herculis).

Variables with long periods of invariable brightness and darkness (as are not uncommon in double stars), though belonging, in a measure, on account of the cause of their variability, to Cl. C., will be better classed in a separate Cl. D.; this class becoming thus finally intimately connected with still another Cl. E., containing the stars which, as so many components in double stars, are varying in colour. The description of the further particulars of these Classes D and E may be postponed to a later occasion.

The case of η Aquilæ and R Sagittæ has been studied by Mr. Roberts (*loc. cit.*, p. 289). In the case of β Lyræ (if my explanation is right) the secondary eclipse minimum must occur in the midst of the periastric maximum. The cooler variable bright-line companion is then between us and its primary. So we comprehend why (the major axis of the orbit being nearly in our line of sight) the bright lines of the companion and the corresponding dark lines of the primary have always been observed as exactly coincident during the secondary minimum, and why, before and after that secondary minimum, these bright lines have been seen displaced respectively to the red and blue sides of their dark representatives. During the principal minimum near apastron no eclipse minimum occurs, because the eclipsed variable, then being in its darkest state, has as little effect upon the brightness of the whole system as the dark companion in the case of Algol. If, however, this eclipse should be total, the bright lines of the companion, which are never wholly extinguished, should temporarily disappear, which phenomenon has been observed indeed by Father Sidgreaves a few hours before the principal minimum (*Monthly Not.* 54, 2, p. 95).

The red companion being relatively small, and completing, moreover, by its red, yellow, and green light, the excess of blue and violet in its primary of Cl. I*a*, the white colour of β Lyræ seems thus to be explicable. The absorption-lines of the companion, though necessarily hard to see on the relatively very bright and more continuous spectrum of the primary, may possibly be detected afterwards. For, according to Prof. Vogel, "especially good photographs have led to the supposition that with sufficient dispersion the spectrum of β Lyræ would be found very rich in lines" (*Astr. and Astrophys.*, 1894, p. 362).

The second investigation, about which I should like to say a few words, is especially important in connection with my idea suggested in Knowledge, December, 1895, that all gaseous nebular spectra may be due to clusters wherein the great majority of stars are Novæ. That hypothesis demands the existence of clusters wherein numerous stars should be mutually equal, and very different from those which are clustered in our neighbourhood. Though this demand seemed to be in a measure supported by the fact that stars of the same description show often a distinctly gregarious tendency, and by Dunlop's and Sir J. Herschel's discoveries of clusters wherein all stars are respectively blue or differently coloured, "like a superb piece of fancy jewellery" (*Obs. at the Cape*, p. 17, a. 102), it has been quite recently much more strikingly verified by Prof. Bailey's discovery, at Arequipa, of certain globular clusters containing an extraordinary number of variable stars (*Astrophys. Journ.*, November). In the cluster N. G. C. 5272 no fewer than eighty-seven stars have been proved to be variable; in the cluster 5904, at least forty-six. On the other hand a similar examination of each of the clusters 6218, 6397, 6626, 6705, and 6752 failed to detect

XUM

SOUTH.

WEST. EAST.

NORTH.

PHOTOGRAPH OF THE NEBULOUS REGION ABOUT 15 MONOCEROTIS.

Taken by Mr. E. E. BARNARD, at the Lick Observatory, Mount Hamilton, California, on February 1st, 1894, with the Willard lens of 6 inches aperture and 31 inches focal length. Exposure, 3 hours. Scale, 1 mm. = 2′ 24″ of arc.

among several hundreds of stars in each cluster one single variable.

Prof. Bailey's discovery, which has been independently confirmed by Mrs. Fleming, Prof. Pickering, and Prof. Hale, gives most valuable support to my idea; and that support is the more valuable because the phenomena of variability, when caused (as is mostly the case) by cooling, have much resemblance to the phenomena of Novæ. What we want now is the spectrum of such a cluster rich in variables. Possibly it will show us the gaseous lines of its numerous dark stars.

THE NEBULOSITY ROUND 15 MONOCEROTIS.

By E. WALTER MAUNDER, F.R.A.S.

THE original of the accompanying photograph was taken by Mr. E. E. Barnard in the course of a photographic study of certain regions of the Milky Way undertaken by him, at the Lick Observatory, with the Willard lens of 6-inch diameter and 31 inches focus. He found the region lying north and east of Orion to be singularly rich in large diffused nebulosities, of which one connected with 15 Monocerotis was most especially noteworthy. Commenting on a plate exposed on January 24th, 1894, for 2h. 30m., on the field of which ξ Geminorum is the centre, he points out* that "this group of bright stars is mixed up with a knotted and wispy nebulosity, extending faintly and irregularly north and westerly to an extent of nearly two degrees. The nebula is irregular in outline, but quite well defined, with numerous black gaps running into it, and in general conforming with the peculiarities of the Milky Way in that region," showing it to be actually mixed up with the Galactic stars, and resembling in this respect a large nebula which Mr. Barnard has photographed in Cepheus. He draws attention to a sinuous vacant strip in this region of the Milky Way running from 15 Monocerotis, at first to the west for some three degrees, and then northerly nearly to γ Geminorum.

The photograph of which Mr. Barnard has kindly sent a copy for reproduction in the pages of KNOWLEDGE, was taken on February 1st, 1894, with three hours' exposure. The diameter of the great nebula is roughly three degrees. Mr. Barnard describes its character as follows: "It clusters densely about the groups of stars, and then spreads out in a weak, diffuse light, with rifts in it, and irregularly terminated along the edges of a vast vacancy in the Milky Way. The condensation, which is very strong, is not at 15 Monocerotis, but twelve minutes south, preceding that star, where it becomes a compact mass, with numerous wisps and holes in it. The whole group of three or four bright stars are involved in this denser wispy light, but 15 Monocerotis itself does not seem to be particularly connected with the nebulosity further than to be apparently in it; that is, there are no indications of condensation about this the brightest star of the group. This remarkable nebula—the denser part of it—is worthy of study with a more powerful photographic telescope."

It will be noted that Mr. Barnard drew special attention to the suitability of the brighter portions of this remarkable object for the more detailed study which might be effected by a more powerful instrument, and the readers of KNOWLEDGE have been put in a position to make such a fuller examination by the courtesy of Dr. Roberts, who supplied the reproduction of his fine photograph taken on February 13th, 1895, which appeared in the February Number of the current volume. The scale of Dr. Roberts' photograph, taken with the 20-inch reflector, is almost exactly six times that of Mr. Barnard's. A rectangle eighty-five millimètres in height, by eight-one in breadth, with its lower edge thirty-two millimètres from the lower edge of the accompanying photograph, and its west side forty-one millimètres from the corrresponding side of the photograph, would inclose precisely the same portion of the sky as is shown on Dr. Roberts' plate.

The two photographs are not, however, for comparison, in the ordinary sense of the word. They were taken with widely different instruments, for widely different purposes; and each is, in its own special line, of the highest beauty and value. The Willard lens brings up the faint widely-diffused nebulosity which is so striking a feature of the region, and gives what one may call a bird's-eye view of the general stellar distribution; whilst in the delicacy and fineness of the details of the nebula which it reveals, in the number of stars shown, and in the neatness and precision of their images, the photograph with the reflector is unapproachable. The two photographs are, therefore, in no sense antagonistic; rather, they are the necessary complements the one of the other.

Beside the great nebulosity around 15 Monocerotis, the photograph shows another of considerable extent discovered by Mr. Barnard whilst sweeping over this region soon after the opening of the Lick Observatory in 1888. It is shown very markedly on the plate as an irregular elliptical mass about thirty-six minutes in diameter. The position of the nebula is given by Mr. Barnard as

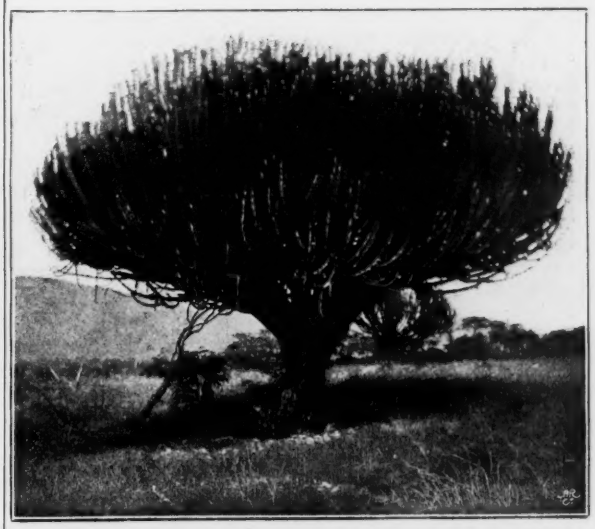
α=6h. 23m. 27s. δ=+10° 7′ for 1860.

The entire photograph covers the region between R.A. 6h. 17m., and R.A. 6h. 45m.; declination between 5° 21′ and 13° 57′ north.

* *Astronomy and Astrophysics*, March, 1894, p. 178.

Notices of Books.

A Naturalist in Mid-Africa, being an Account of a Journey to the Mountains of the Moon and Tanganyika. By G. F. Scott Elliot, M.A., F.L.S., F.R.G.S. (Innes.)



Euphorbias of the Albert Edward Plains. From "A Naturalist in Mid-Africa."

Illustrated. 16s. Mr. Scott Elliot's object in undertaking the expedition of which this book is a description was entirely a botanical one. Unlike most books of travel,

we are not wearied in the one before us with minute descriptions of each day's march, and the book will prove interesting reading to everyone. Beyond this it is full of valuable information and shrewd conclusions bearing on the natives, natural history, and general aspect of the region traversed. The author seems to have been greatly hampered by fever and other ills, and although the results of the expedition are not startling, a considerable amount of useful work has been done. The book is provided with two maps—one, showing coffee zones and areas fit for colonization, being particularly instructive. Although the illustrations, which are taken from the author's photographs, are not very successful as pictures, they are very useful in showing the characteristics of the country. Altogether the book is a valuable one, and especially so to naturalists and those (and who is not ?) interested in Africa.

Birds from Moidart and Elsewhere. By Mrs. Hugh Blackburn. (Edinburgh : David Douglas.) Illustrated. The illustrations occupy the bulk of this volume. They have been exceedingly well reproduced from drawings by the author, mostly from life. Some of the drawings are excellent—perfectly natural and accurate—notably those of the tawny owl on page 28, and the guillemot on page 162. A good many of the drawings, however, are stiff and unnatural. Although limited, the text has considerable value, as Mrs. Blackburn has written solely from personal observation. Moreover, she has had many opportunities for observing rare birds. These observations have been faithfully recorded, and on this account the book will prove of undoubted interest.

The Structure and Development of the Mosses and Ferns. By Prof. D. H. Campbell, Ph.D. (Macmillan.) Illustrated. 14s. Within the past ten years a large number of investigations have been made upon the structure and development of the numerous plants included under the name Archegoniatæ. "The present work was undertaken," says Prof. Campbell, "mainly for the purpose of presenting in somewhat detailed form a *résumé* of the substance of the great mass of literature upon the subject which has accumulated, and much of which is necessarily out of reach of the many botanical workers who have not access to the great libraries." The author himself has greatly assisted in extending and improving the knowledge of the Archegoniates, and some of his papers form the basis of this book, while the results of researches upon representatives of most of the groups discussed are now published for the first time. The book thus possesses the sterling ring which results from personal observation, and is thereby distinguished from mere compilations. Botanists should be grateful for this solid and comprehensive contribution to the literature of the Archegoniate series—the best that has appeared for some years. Prof. Campbell's work will be long recognized as a standard one for students of the structure, development, and inter-relationships of the lowly but important families of plants described in it.

Our Household Insects. By Edward A. Butler, B.A., B.Sc. (Longmans.) Illustrated. Mr. Butler's writing is too well known to readers of Knowledge to need any eulogium on our part. The book before us is an interesting series of articles, which originally appeared in Knowledge, on the insect pests found in dwelling-houses. Although the book is intended primarily for the novice, it will, no doubt, be of considerable service to more advanced students of entomology, because it brings together information which has hitherto only existed in a scattered form. The illustrations, which have been prepared from microscopical slides, are excellent, and the book deserves every commendation.

By Tangled Paths: Stray Leaves from Nature's Byeways. By H. Mead Briggs. (Warne.) Illustrated. Rather a mixed collection of short essays is brought together in this book. The author's style is quaint, and is rather suggestive of "padding." But it is pleasing in parts, and although the book will not bear close reading it makes a delightful volume to skim through. Birds form the chief subject, but the author makes frequent digressions and often strays from "nature's byeways."

The Story of the Solar System. By George F. Chambers, F.R.A.S. (George Newnes, Ltd.) Illustrated. 1s. This little book provides accurate and interesting reading on planetary astronomy at a price within the reach of everyone, and we trust that the publisher's enterprise and the author's work will be rewarded by a large sale. "Astronomy, like charity," someone has said, "should begin at home"; and the remark has much to commend it. Therefore we say to those persons who wish to commence the study of astronomy, Procure this descriptive and practical account of the astronomical home-circle, and you will derive from its perusal a sound foundation upon which to erect future knowledge. We are glad to be able to state that the illustrations in the present book are far better than those of the companion volume, in which the "Story of the Stars" is told.

A Laboratory Course in Experimental Physics. By W. J. Loudon, B.A., and J. C. McLennan, B.A. (Macmillan.) Illustrated. 8s. 6d. It may be possible to write a perfect book on experimental physics, but it has not as yet been accomplished. It is, therefore, not invidious to say that in this volume, which in many respects is well presented, there exist blemishes which could have been avoided. The book is divided into two courses, of which the former deals with instruments for measuring lines, hydrostatics, optics, and heat in a very elementary way. The latter treats of sound, of heat more fully, and of magnetism and electricity. At the end there are short additions on gravity determination and on the Torsion Pendulum ; and, of course, there are some tables borrowed in the usual way, and not always transcribed with perfect accuracy. The chief fault in the book is that, in spite of its title, it is written too much from the theoretical standpoint. In the hydrostatic methods of determining specific gravities no instruction is conveyed on the important correction rendered necessary by the buoyancy of the air, neither is anything said about volume determinations by the hydrostatic balance. But probably the optical portion of the book is the least satisfactory. The use of the collimator in goniometrical work seems to be quite misapprehended. The instructions imply (and a figure actually supports this view) that only a narrow beam of light issues from the lens, as from a slit, for the student is told to carefully place the edge of the prism accurately at the centre of the instrument. The optics are, in fact, far from practical. But acoustics and heat are handled more completely. The many practical points which have actually to be attended to are either not noticed at all or only in a very incomplete way. The authors, however, make an observation in describing the determination of magnetic inclination from which the Kew Committee of the Royal Society may derive illumination, viz. : that if the instrument is turned through two right angles to eliminate certain errors for which that operation is necessary, then other errors, for the correction of which directions are given in the Kew system to reverse the needle on its agate bearings, also disappear, so that this latter operation really is waste of time.

Consider the Heavens: a Popular Introduction to Astronomy. By Mrs. W. S. Aldis. (The Religious Tract Society.) Illustrated. 2s. 6d. "The heavens declare the glory of

God, and the firmament sheweth His handiwork." This appears to have been the text which Mrs. Aldis had in mind when preparing the book before us. Taken altogether the Biblical quotations aptly illustrate the points in connection with which they are employed, and the book loses nothing by their use. We have carefully gone through the text, and have come to the conclusion that it is admirably and accurately composed. The chief criticism we have to offer applies not only to this book but to others of a similar kind; it relates to the practice of using without acknowledgment the ideas of other authors. Anyone familiar with astronomical literature will have no difficulty in naming the sources from which Mrs. Aldis has drawn much of her information. For instance, an impressive word-picture drawn by Young to convey an idea of the intensity of solar radiation is used on page 50 without a line of credit to the originator; and there are many similar cases. We think that the authoress should have given references to the works of a modern philosopher like Young, just as much as she does to those of the prophets of old. A half-dozen or so excellent illustrations brighten the pages of the book, but the remainder of the twenty-nine are either old friends or line diagrams, and are not worthy of the text. Taken as a whole, the book is a remarkably clear and easy guide to astronomy, and one for which we anticipate a successful career.

Evolution, and Man's Place in Nature. By Prof. Henry Calderwood, LL.D., F.R.S.E. 2nd Edition. (Macmillan.) Illustrated. 10s. *The Present Evolution of Man.* By G. Archdall Reid. (Chapman and Hall.) 7s. 6d. The first edition of Prof. Calderwood's book appeared in 1893, and though it received some adverse criticisms from materialistic reviewers, it secured the approval of many readers and thinkers interested in the philosophical aspects of evolution. The present edition is practically a new work, for, in order to meet the demand for a detailed statement of the evidence upon which his conclusions are based, Prof. Calderwood has rewritten almost the whole of the matter, and has added nine new chapters. The purpose of the volume is to show that the history of mind is distinct from the history of organism. We cannot do better than give the author's own words to define his position :—

"The evolution of brain," he says (p. 293), "as represented in the successive stages of the monkey, the ape, and man, has proceeded in accordance with the history of evolution in the lower order of vertebrates. These three higher stages, in so far as they illustrate continuity of organic life, are accounted for by the cosmic process which has had constant application to animate life. The marked superiority of the human brain arises in part from the erect posture, with disuse of the fore limbs for locomotion and their application to industrial effort; in part from use of the organ for fulfilment of rational purpose. Intellectual activity, unexplained by organic functions, has given a new development to human organism, making brain the organ of mind, and effecting a combination of forces, physical and intellectual, found nowhere else in nature."

There are many who believe that the rational and moral nature of man has not been evolved in the same way as the bodily organism and the lower mental nature; and they will find pleasure in going through the mass of evidence brought forward in support of that view. "The grand distinction of human life," to again quote the author, "is *self-control in the field of action*," and in that fact lies the key to the elevation of mankind. To readers used to concise statements, the author's diffuse style will be annoying; but in spite of this they will find that the volume will considerably broaden their views of life, and show them the reality of processes not referable to protoplasm.

Dr. Reid's volume is somewhat similar to Prof. Calderwood's, inasmuch as it deals not only with man's physical evolution but also with his mental evolution. The work is divided into two parts: one dealing with the problem of evolution in general, and the second applying the conclusions arrived at to the problem of man's present evolution. Following Weismann, Dr. Reid holds that acquired traits, both physical and mental, are never transmitted, and he brings forward many original arguments in defence of his position and against the views of Mr. Herbert Spencer. Students of biology, broadly understood, and psychologists will find the first section of the volume well worth reading, and general readers will derive from it a fund of information on many biological problems of the present day. As to the second part, we think that the theory advanced therein is undoubtedly valuable. From the conclusion that men perish mainly by disease, the inference is drawn that man's present evolution must be principally against disease. To take an example: we are able to live in a climate which is fatal to the inhabitants of much the greater part of the world, while, on the other hand, the west coast of Africa is an unhealthy region for us. The explanation of this is, *pace* Dr. Reid, that our race, which is able to persist under conditions adverse to other races, has undergone an evolution in relation to tuberculosis fully equal to the evolution against malaria undergone by the West Africans; in other words, races become acclimatized by natural selection to the conditions of the areas in which they live. The immunity thus gained is held to result solely from inborn variations. Besides diseases there are agencies, such as alcohol, opium, hashish, and other narcotics, all of which assist in the elimination of the unfit. Dr. Reid exhibits the effects of each of these causes on "the present evolution of man," and points to the lessons they teach as to the directions of development in the future. We have read his work with pleasure, and pronounce it worthy the attention of all who are interested in the teachings and consequences of evolution.

Manual of Lithology. By Prof. Edward H. Williams, jun., E.M., F.G.S.A. (John Wiley & Sons: Chapman & Hall.) Illustrated. In this second and very considerably enlarged edition of a valuable manual of lithology, the principles of the science are treated with special reference to megascopic analysis. The engineer and prospector could hardly desire a more systematic and practical handbook to the rocks than this, and, in our opinion, no student should devote himself to the study of petrography before he is familiar with the facts herein contained. Work with the unaided eye (megascopic analysis) should always precede the microscopic analysis of mineral constituents of rocks; in other words, lithology is the natural introduction to petrography, spite of the separation brought about between them by the microscope. Before dealing with lithology proper, which treats of rocks as mineral aggregates, the author touches upon that branch of the subject—mineralogy—which is concerned with individual components, by devoting a chapter to rock-forming minerals. An excellent collection of definitions relating to the association in nature (geological), mineralogical and physical states of rocks, and a brief statement of theories of rock formation from fluid magmas introduce the section on primary or eruptive rocks. Secondary and metamorphic rocks are successively dealt with in two other sections of the volume. Finally there is a chapter on minerals as rocks, and one on the economic value of rocks; while six plates exhibit the megascopic structure of the surfaces of thirty-six rock specimens. To the student of structural geology, and to practical men, Prof. Williams' manual can be confidently recommended.

XUM

Insect Life. By Fred. V. Theobald, M.A., F.E.S. (Methuen.) Illustrated. This book, which is one of the University Extension Series, sets forth very clearly and concisely the chief characteristics and economic importance of the different orders of insects. It also deals with the life history and structure of many interesting species. Two useful appendices are added, the one on different ways of destroying insect pests, while the other comprises a list of the most important works on special groups of insects. Mr. Theobald's book will be found of great use to those who want to gain a general knowledge of insect life.

BOOKS RECEIVED.

Text-book of Comparative Anatomy. By Dr. Arnold Lang. Translated by H. M. Bernard, M.A., and Matilda Bernard. Part II. (Macmillan.) Illustrated. 17s. net.

The Astronomy of Milton's "Paradise Lost." By Thomas N. Orchard, M.D. (Longmans.) Illustrated. 15s.

British Sea Birds. By Charles Dixon. (Bliss, Sands, & Foster.) Illustrated. 10s. 6d.

A Handbook to the Birds of Great Britain. By R. Bowdler Sharpe, LL.D. Vol. III. (Allen.) Illustrated. 6s.

Our Country's Butterflies and Moths. By W. J. Gordon. (Day & Son.) Illustrated. 6s.

Historical and Future Eclipses. By Rev. S. J. Johnson, M.A., F.R.A.S. New Edition. (Parker & Co.) Illustrated 4s. 6d.

The Composition of Expired Air and its Effects upon Animal Life. By J. S. Billings, M.D., S. Weir Mitchell, M.D., and D. H. Bergey, M.D. (Washington: Smithsonian Institute.)

A Laboratory Notebook of Elementary Practical Physics. By L. R. Wilberforce, M.A., and T. C. Fitzpatrick, M.A. (Cambridge University Press.) 1s.

James Clerk Maxwell and Modern Physics. By R. T. Glazebrook, F.R.S. (Cassell.) The Century Science Series. Illustrated. 3s. 6d.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

ELECTROGRAPHY.

To the Editors of Knowledge.

Sirs,—I read Mr. J. W. Gifford's article on electrography in the April Number of Knowledge with great interest. I should, however, like to draw your readers' attention to the fact that the electrician Hertz, mentioned in this article, was not a Swiss but a great German professor.

He was born on February 22nd, 1857, in Hamburg, and after having studied in Munich and Berlin (under Helmholtz) he became, in 1885, Professor of Physiology in Karlsruhe, and followed Clausius in 1889 at Bonn, where he died on January 1st, 1894, after a short but brilliant career.

North Woolwich. E. Wohlwill.

ZODIACAL LIGHT (?).

To the Editors of Knowledge.

Sirs,—Your correspondent, Mr. Lyon Browne, will find a very similar appearance to that seen by him on the 4th of March described as seen by Dr. Brauner, of Prague, on the 13th of the same month, in *Nature* for March 28th, except that Dr. Brauner saw five streaks instead of one. And if he will refer to Knowledge for 1883 he will find similar appearances described by Captain Noble and Mr. Bradgate as seen by them (at different hours) on the night of August 28th, 1883, and by Mrs. Harbin on September 21st, 1883, except that these appearances were in the eastern, not the western, horizon. I saw a similar appearance in the east on the 4th of September, 1885. The phenomenon appears to have been taken on other occasions for a comet or comet's tail by Mr. Eddie, at Grahamstown, and by Mr. Edwin Holmes; and a similar mistake seems to have occurred so far back as the year 1761, judging from the *Annual Register* of that year. By others (myself included) it has been mistaken for a meteor or meteor-track, but its real character has yet to be explained. Possibly it is more akin to the Aurora Borealis than to comets, meteors, or the zodiacal light. It would be interesting to know whether there were any electric or magnetic disturbances on the nights when it has been noticed, of which we may safely set down August 28th and September 21st, 1883, September 4th, 1885, and March 4th and 13th, 1896. It seems to appear in the east in autumn and in the west in spring, if we may judge from the few observations that I have been able to collect. Perhaps some of your readers may be able to add others.

W. H. S. Monck.

To the Editors of Knowledge.

Sirs,—I also saw the phenomenon described by Mr. Lyon Browne in the April Number of Knowledge. It was about 8.55 p.m. when I first noticed an unusual streak of light in the west. I watched it with a field-glass for quite twenty minutes. At 9.20 it had become exceedingly faint and ill-defined, and a few minutes afterwards had disappeared. It appeared to me a broad column of light, sloping towards the south at an angle of about sixty degrees with the horizon. Its base was (as your correspondent states) about five degrees in width, and appeared to spring from a bank of clouds low down. From this base the light extended upwards about twenty or twenty-five degrees, tapering gradually to a point, which, however, was very faint and indefinite. The margins of the light were fairly distinct. The said margins appeared to be very slightly curved, so that the light had the shape of a spear-head, or, more exactly, the outline of the section of a thin double convex lens. Its brightness was considerable. It was *much brighter than the Milky Way*, and looked more like moonlight when it struggles through cloud or mist. I am not quite certain that it moved slightly towards the south, but I am quite sure that at nine o'clock its northern border towards the apex was nearly touching two bright stars near together and below the Pleiades, but that about ten minutes later it was two or three times its own diameter to the south of them. Now what was this light?

I see that someone writes to the *English Mechanic* confidently describing it as an "auroral streamer." I have seen Aurora frequently, but never like this. On the other hand I have never been able to see the zodiacal light, which is always described as very faint and difficult to observe, so that I could hardly believe I was actually beholding that difficult object. And yet its shape, position, and inclination?

Iron Bridge, Salop. T. Law Webb, M.R.C.S.
27th March, 1896.

To the Editors of Knowledge.

Sirs,—I should like to say a few words in reference to the "unusual phenomenon" observed on March 4th, and described by Mr. W. L. Browne, jun., in your April Number. I feel no doubt in my own mind that it was an auroral streamer, an impression confirmed by two letters in the *English Mechanic*. My attention was called to it here at 9.15, shortly before it faded away, but it was visible for about an hour previously. Had I been able to watch it from the first I might have detected some motion. At 9.15 it was nearly due west, the sky being cloudless, with a little mist on the horizon. I find that it was noticed in other places in England, and that a discussion took place at the meeting of the Royal Astronomical Society on the 13th as to its nature. I may add, as confirming my own conviction, that it singularly resembled a beam of light which I observed last year in nearly the same

position on March 13th, when Aurora was also visible in Scotland and the North of England—one observer stating that at 8 P.M. the whole of the northern sky was full of Aurora. Why these appearances were only seen in our more southern latitudes in the west instead of in the north is a question which requires explanation. It is possible that there may have been glows over the north horizon contemporaneously, but this locality is too much obscured by trees to observe them. E. BROWN.

Further Barton, Cirencester.

To the Editors of KNOWLEDGE.

SIRS,—The appearance described in Mr. W. L. Browne's letter in the April Number was seen here. We saw the streak of light, as he describes it, issuing from behind a dark cloud on the west-north-west horizon, bright enough to attract attention through a screen of trees, on March 4th. It faded in about ten minutes from the time we first noticed it; it was, however, 9.20, not 8.30, when we saw it. It was not so long as Mr. Browne describes it. I should have said that it did not extend so much as a third of the way to the zenith, but the upper part may have been hidden by cloud. The sides were well defined and parallel, but, as I remember it, it was slightly inclined to the horizon from north to south. One would have thought it a search-light, but for its coming from behind the cloud, and the fact that there was no place in that direction where such a thing could be. W. H. A. COWELL.

St. Edward's School, Oxford,
April 2nd, 1896.

To the Editors of KNOWLEDGE.

SIRS,—Although the weather has of late hindered astronomical observation, I have seen the zodiacal light several times during March, and read with great interest Mr. Lyon Browne's letter in your April Number. It may interest your readers to hear that it was most distinct on March 30th, but it was fan-shaped, and not nearly so bright as when seen by Mr. Browne at Shrewsbury. It was quite distinct from 7.30 to 9.30, and stretched fully half-way to the zenith when viewed with the naked eye; and with the aid of my telescope I thought I could discern it even further. On the north-west horizon it was about five degrees in breadth, but increased greatly as it got nearer the zenith.

32, Primrose Hill Road, W. G. BUSZARD.
London, N.W.

[Observations which have come more recently to hand show conclusively that the remarkable light seen on March 4th by Mr. Lyon Browne and so many other observers was auroral in character. From the first it was quite clear that it was not a comet; it was seen too late in the evening to have been a "sun pillar," as some of the observations referred to by Mr. Monck may possibly have been; and though its direction, as described, coincided as nearly as we could expect with the axis of the zodiacal light, which was distinctly seen the same evening, yet its appearance was quite different from the faint, broad, lenticular-shaped glow which the zodiacal light usually presents. There was an unmistakable Aurora seen later in the evening, and some observers were able to follow out clearly the connection between the two. The instances of similar strange lights which Mr. Monck mentions were none of them coincident with large magnetic fluctuations, except that of September 4th, 1885; and even in that case the magnetic disturbance fell rather later than the observation of the light.—E. WALTER MAUNDER.]

SUN PILLAR.

To the Editors of KNOWLEDGE.

SIRS,—The sun pillar was visible here at 6.20 P.M. on March 31st.

The sky was light red inclining to orange, and the noticeable feature in the column rising from the sun was that it was formed on (apparently) and was transverse to the long level bars of cirro-stratus crossing the western sky.

No cumulus was visible.

The column appeared slightly tremulous. It was more defined at the edges and slightly narrower than that figured by me in KNOWLEDGE, June, 1895.

On the following day there was a thick drizzle of rain.

Seasalter, Whitstable. (Rev.) SAMUEL BARBER.

To the Editors of KNOWLEDGE.

SIRS,—On March 27th a sun pillar was visible here from ten minutes past six until shortly after sunset. The sun was shining between cirrus clouds, and the pillar, of the same width as the diameter of the sun, shaded off gradually through similar clouds. Its colour was a faint yellow.

A brilliant appearance of the so-called "sun-dogs" was seen from several places in this locality on the same evening.

At the time, and throughout the following day, a cold north wind was blowing. Heavy rain fell during the night, but since the weather has been fine and dry.

Exeter. W. E. BESLEY.

WAVES.—V.

THE TIDE WAVE.

By VAUGHAN CORNISH, M.Sc.

THE attraction of the moon or of the sun is equally exercised upon all parts of a sheet of water of such size as the Mediterranean, so that scarcely any tide wave is raised there; but in the Pacific Ocean, which is the chief cradle of the tides, the attraction of, say, the moon, is at any moment appreciably different in different parts, and the waters heap themselves up into a long, low hillock, which follows the moon in her apparent motion from east to west, traversing the ocean at vast speed as a forced long-wave. Two such billows are formed by the moon in each twenty-four hours, for when the moon is on the opposite side of the earth the solid globe is pulled away from the waters, leaving them heaped up, so that the result is much the same as when the moon is overhead. The long, low, billows which are formed by the moon's action in the equatorial regions where the ocean girdles the earth, travel on as free waves into the higher latitudes, penetrating every open sea and channel. These free tide waves run under the action of the earth's gravity, almost exactly in the same way that the solitary wave travels on in a canal when the motion of the canal boat has been arrested. Like the solitary wave formed in canals the tide wave is a long wave, for the moon's attraction being practically equal at the surface and at the bottom of the sea, the motion of the water particles is the same at the bottom and at the surface. The motion of the water is mainly a backward and forward swing, the vertical motion being very small compared with the horizontal motion. The rapidity with which such a wave travels when left to itself—or rather to the force of the earth's gravity—depends upon the depth of the channel, because the deeper the channel the smaller is the quantity of water which has to be transmitted through each unit of

cross section in order to maintain the hillock upon the surface. In the deep waters of the open ocean the height of the tide billow is very small—say, from one to three feet. As the wave approaches the shallowing slope of the shore the front of the billow is retarded while the hinder parts press on, and the height of the wave is thereby increased. The height of the wave is also increased when it reaches a narrowing channel in which the billow is laterally compressed. Thus the highest tides are not in the open ocean where the tides are generated, but in the distant channels, bays, and inlets, where the tide wave penetrates after the moon has left it to run its course. Once every twelve hours, as we have seen, the moon raises a billow and drives or drags it forward as a pulse of water in the southern oceans, much as the heart, in its rhythmic beat, drives the blood-pulse into the arteries. But, whereas the blood-pulse runs the whole length of the artery, and is lost in the capillaries before the next stroke of the heart sends out a second pulse, the tide wave, on the other hand, has not reached the most distant shores when the next succeeding pulse of water is set going by the moon. The tide wave of which the crest may round the Cape of Good Hope at noon, travels up the west coast of Africa and reaches the Azores about midnight. By this time it is followed by a second pulse, which is now rounding the Cape. It is four o'clock in the morning before the crest of the first wave has reached the entrance of the English Channel, where the shallower water makes it travel slower. It takes another six hours to run the length of the Channel, reaching the Straits of Dover at 10 A.M., where the height of the wave is considerable, owing, partly, to the narrowing of the Channel. Thus, at Dover the water rises twenty-one feet, and this occurs at Dover about six hours after the wave crest passed the Land's End. Now, the next incoming tide billow on its way from the Southern Ocean has not yet got as far as the Azores, and the water at the entrance to the Channel is at a low level—this being, in fact, the position of the trough between two succeeding tide billows. Therefore, when we have the water heaped up (and pent up, too, for the Straits are narrow) near Dover, the water being low at the other end of the Channel, the action of the earth's gravity sets a long wave travelling back from Dover towards the Land's End; and this is the ebb tide in the English Channel. The time which a free long wave takes to travel the length of the Channel being about six hours, the return wave will at 4 P.M. have emptied the Channel of nearly as much water as was sent in by the tidal billow.

This is just twelve hours since the last tidal billow arrived at the mouth of the Channel, and at this moment the next billow comes running in from the South Atlantic, and "the tide" again runs up Channel. Thus the natural period for the passage of a free long wave up and down the Channel coincides with the interval between two tide pulses. Were it otherwise—if, for instance, the tide were ebbing from Dover, and at the same time the crest of the succeeding pulse were, say, at Portland—the rise and fall of water in the Channel would be much less than is actually the case. As it is, what happens in the Channel can be well illustrated by sending a wave along a trough by tipping up one end, and keeping the wave going backwards and forwards by again gently tipping the same end of the trough just as the wave returns to where it started from. It will be noticed then that there is a considerable rise and fall of water at each end of the trough, with little horizontal motion there; at the middle point there is hardly any rise and fall, but a considerable horizontal swing of the water. The same thing happens in the Channel. The rise at Dover is twenty-one feet; at Portland the rise and fall is scarcely perceptible, but here are the strongest tidal currents, forming the well-known Portland Race, which rushes (eastward on the flood and westward on the ebb) past the rocky promontory, leaping and foaming over the "Ledge" in a wild turmoil of water, dreaded by the mariner, but fascinating to the watcher of waves—when he is on *terra firma*. We shall have more to say about the Portland Race in our next article, when we are dealing with waves in running water.

We traced the tidal billow on its rapid course up the South Atlantic as far as the south-western coasts of the British Isles. Here the wave divides, and while one part runs up the English Channel as we have described, and is nearly, though not quite, stopped at the Straits of Dover, the other half takes a western course, swings round the North of Scotland, and travels comparatively slowly—say forty miles an hour—along our eastern coasts in a southerly direction. It is this part of the original tidal billow which furnishes the greater portion of the wave which once in every twelve hours enters the tideway of the Thames. In this comparatively short tideway of, say, seventy miles, there is never more than one wave crest at a time, the free long wave running up to Teddington Lock and back again to the entrance of the tideway before the next tidal billow reaches the Nore. In a long tideway, such as that of the Amazon, the case is different, for there are at any moment a number of wave crests travelling up the channel. They enter the mouth of the tideway at intervals of twelve hours, and follow one another up the river as a train of "solitary" waves; but between each pair of crests is, not a flat surface, but a trough, which is the negative, or inverted, crest of the negative, or ebb, tide wave. Where the billows or hillocks are, the current runs up stream; where the hollows are, the water runs down stream.

Neglecting, at first, the effects of the shallowing of the river channel and of friction, we may represent by Fig. 2 the wave of flood tide followed by the wave of ebb tide, but necessarily with an exaggerated height; the arrows show the direction of the flow of water during flood and ebb tide. Let us deal with the tide in the Thames, and suppose an observer to place himself at London Bridge. When the point A is opposite to him it is slack water; when A has passed the current begins to flow up stream—slowly at first, and afterwards more quickly, the level of the water on the banks rising the whole time. When B, the crest of the wave, is opposite, it is high water at London Bridge, and the up-stream current is at its strongest. When high water has passed *the current continues to flow up stream*, but at diminishing speed, *the level of the water falling all the while*, until when the point C is opposite the post of observation slack water is reached. The current then turns, and flows down stream, slowly at first but gaining speed, the level of the water continuing to sink until the point D is opposite, when it is low water and the stream of ebbing tide is running its fastest. From that point the level of water begins to rise while the current continues to run down stream. When the point E is opposite the post of observation it is again slack water and the tide current is on the turn; the point E corresponds with point A, and the cycle of phenomena which we have described begins again.

The effect produced by the shallowing and narrowing of the river as we proceed up stream, and by friction with the banks and bottom of the channel, is to retard the progress of the front of the wave as it travels up stream while the hinder part of the billow presses on, so that the front of the billow becomes steeper than the back, much

as in the case of the wind waves of the sea when they reach the shallowing slope of the shore. A very noticeable result of this shortening of the front part of the billow is that on the flood tide the interval between slack water and high water is shorter than it would be if the form of wave

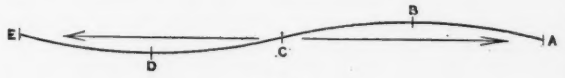


FIG. 1.

were as shown in Fig. 1, and that on the ebb tide the interval from high water to slack water is longer than the corresponding interval on the flood tide.

When the channel of a river narrows very rapidly the front of the tide wave becomes so short and steep that a *bore* is formed, in which, at last, we have the tide wave as a visible billow. In studying the tide waves of sea and ocean, and even of most rivers, we are at a disadvantage from the fact that the slope of the billow is so gentle and the length of the billow so great that the progress of the wave crest cannot be followed by the eye, and we are apt in actual observation to forget the invisible wave propagation while noticing the phenomena of rise and fall and of currents. This difficulty, which at first besets the study of the tides, is the converse of that met with in studying the wind waves of the sea, in which the progress of the wave crest fascinates the eye while the motions of the water as the wave crest passes elude the observation.

The River Severn affords a fine example of the bore, which is to be seen also in many other rivers which have a funnel-shaped estuary. When the channel of the river is very shallow at the sides, and bordered at low tide by broad flats of mud or sand, the phenomenon is particularly fine; the wave, which moves as an unbroken wall of water up the deep part of the channel, breaking in the shallow parts, and the water then rushes over the flat sands in a roaring surf. Our illustration (Fig. 2) shows the Severn Bore a few miles below Gloucester, at a place called Stonebench, where a ledge of rock projects into the stream and probably causes the breaking of the wave near the left bank of the river. The bore is not the whole of the front slope of the tide wave, for after the bore has passed the level of the water continues to rise, the current flowing rapidly up stream. At a distance of about six miles below Gloucester the rise of level has been observed to cease about one and a half hours after the passing of the bore. At this time the current is still flowing slowly up stream. In about a quarter of an hour the current turns seaward, running slowly at first but soon gathering strength, until it attains a speed seldom met with in other rivers.

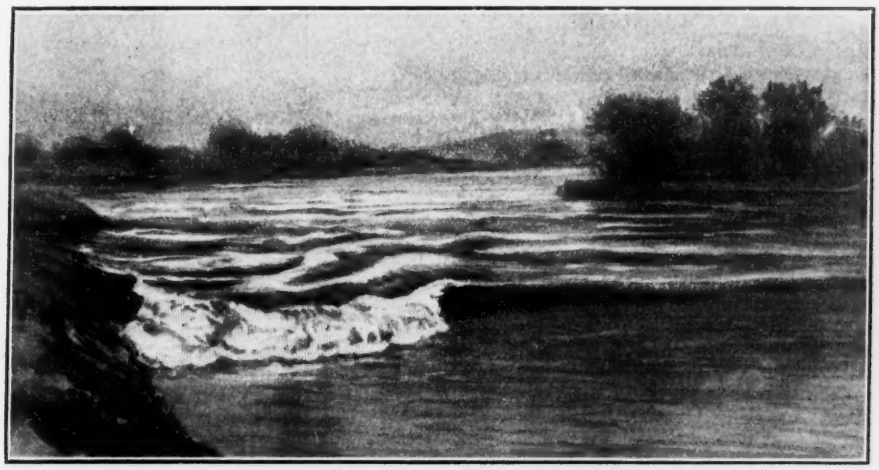


FIG. 2.—The Severn Bore from Stonebench.

The *ægre* of the Trent is another fine example of the bore in a tidal river.

Having now traced out the somewhat complicated connection between the rise and fall of water level and the direction of current in the tide wave of rivers, we are in a better position to explain the tidal currents of the English Channel, and their relation to the times of high and low water on the coast.

In mid-Channel the course of events is very similar to that in a river, viz., when it is high tide there the current is running its strongest up Channel; it continues to run up till half tide, then turns, and is running down Channel most swiftly at low tide. Close in shore, especially in bays, matters are very different. The front of the tidal wave as it runs up Channel is of course curved, for the sides of the Channel are shallow, and there the motion of the wave is retarded. Just as in the case of ordinary wind waves, the crest swings round and advances dead on shore. Hence, when the tide is flowing in the Channel the current *near the shore* is running towards the shore. At high tide, the crest of the wave being reached, the waters close on shore can flow no further, for they are stopped by the shore as by a wall; consequently it is slack water close in shore at high tide. After high tide the current here turns and flows off shore. At a position intermediate between mid-Channel and the shore the course of the currents is a compromise between these we have so far described. At low water the stream is down Channel; then, as the tide rises, the current is partly down Channel and partly shorewards. At half flood tide the current is directly towards shore; at high water directly up Channel, then partly up Channel and partly off shore; at half ebb directly off shore, and at low tide again directly down Channel: so that in the course of one complete tide the current flows towards every point of the compass in turn.

The work of the tides in the transport of sand and shingle, mud and silt, does not in its details come within our present scope, but a few points must be touched upon which serve to illustrate the matters we have dealt with in this article.

In tidal rivers mud and silt is deposited at each portion of the tideway in succession when slack water occurs there. In this respect the navigation of tidal rivers presents a disadvantage as compared with rivers which flow into non-tidal seas, in which the uninterrupted current carries away the mud and silt. This, however, is deposited off the mouth of the river, where the force of the current

is lost; and in tideless seas, where there is no scour of coast tide-current to remove the deposit, the mouth of the river becomes choked.

Anything which tends to check the passage of a tide wave up or down a river has, generally, a bad effect upon the channel, increasing the deposit of mud. The removal of old London Bridge, with its numerous piles and broad foundations, considerably improved that part of the tideway of the Thames, by enabling the flood tide to flow up more freely and by increasing the scour of the ebb.

In the transport along the coasts of the sand and shingle which are formed by the action of the breakers, several circumstances concur to prevent the action of the tides from being simply a reciprocating removal and restoration of material, such as the oscillatory character of the tide might lead one to expect. Not only is the ebb tide not necessarily the exact reproduction of the flood tide, but the coasts are not symmetrical either in form or material with respect to the direction of flow of the tides. Material is in general scoured off the promontories, where the currents run strongly, so that no beaches are left, and is deposited at slack water (*i.e.*, at high tide) in bays and inlets. The transport is to some extent in both directions from a headland, but chiefly in the direction in which the tide runs most strongly, or in which the wind exerts most force (from west to east in the Channel, and from north to south on our east coasts). The prevailing trend of tidal transport on our southern and eastern coasts is well shown by the positions in which banks of shingle accumulate. Thus, in the Channel, we have the Chesil Beach to the west of Portland, and the shingle bank in a corresponding position at Dungeness; while, on the east coast, Lowestoft Ness grows southwards by the deposit of shingle brought from the north. In the same way, on the east coast, the accumulation of shingle has shifted the mouths of the Yare and the Ald several miles to the south of Yarmouth and of Aldborough. In the latter case the river runs for miles parallel to the sea, from which it is separated only by a bank of shingle. On our west coasts the direction of tidal transport is from south to north.

The principal sand deposits are situated differently from the great shingle banks, as we see, for instance, in the Channel, by the sandbanks near the mouth of the harbour of Poole, in Dorset, which are formed on the eastern and more sheltered side of the promontory called Purbeck Island.

BABYLONIA AND ELAM FOUR THOUSAND YEARS AGO.

By Theo. G. Pinches, M.R.A.S.,

Department of Egyptian and Assyrian Antiquities, British Museum.

THE cuneiform inscriptions of Babylonia and Assyria have thrown a flood of light upon the history of the countries in which they were written. That they would do so was to be expected; but they also incidentally restore the history of the nations around, and one of the powers of which their records constantly speak is Elam. Thus one of the important facts of the early history of Babylonia and Elam is that related by King Assur-banî-apli, of Assyria, who tells us that 1532 or 1632 years before his time (= 2180 or 2280 B.C.) Kudur-nankhundi, King of Elam, invaded Akkad or Babylonia, and carried off from Erech the image of the goddess Nanâ; and contemporary documents furnish us with the names of Simti-silkhak and Kudur-mabug, his son, Elamite kings who reigned in Babylon, probably at a somewhat later date. For other periods native records furnish some data, and the Babylonian Chronicle and Assur-banî-apli's history of his reign are of great value. Though the gaps are many, it must be admitted that satisfactory progress in restoring the lost history of Elam has been made.

No inscription, however, had revealed to the explorer in the realms of Assyriology the name of Chedorlaomer, of Genesis xiv. Kudur-Nankhundi and Kudur-Mabug had been found, but Kudur-Lagamar (or Lagamal), which would have been the Babylonian form of Chedorlaomer, was wanting. Not only was this royal name lacking, but those of Tidal and Amraphel, his companions, were absent too. The name of Arioch alone, of the four allied kings who went against Sodom, had been recognized in the inscriptions.

Yet Chedorlaomer, Tidal, and Amraphel were important rulers—powerful in the extreme, to come so far (all the way from Elam and Babylonia) to the valley of the Jordan, to defeat and subjugate again the nations of the district, which had rebelled against them. Was the story true, or merely a romance? Why did these names not occur in the extensive literature of Babylonia and Assyria?

It would probably be a difficult matter, even now, to answer all the possible questions that a well-armed critic might put; but we can at least say one thing, and that is that we are in a better position to answer them than we were a short time ago.

It came about in a very simple manner. Being on the look-out for historical texts, the writer chanced upon one of more than ordinary difficulty, which he decided to copy. It was a tablet of a late date, probably of about 350 B.C., and it was very mutilated; but one name shone out with an attractive clearness, namely, that of "Tudkhula, son of Gazza—*." Now, any Assyriologist would have had the thought that immediately occurred to the writer: Can this be the Tidal† of the Hebrews? The consonants all corresponded—it was the vowels alone that differed; but even these did not differ more than those of Tukulti-apil-êsarra do from the Hebrew (and Aramaic) form of the name Tiglath-pileser. Proceeding, therefore, hopefully, there were found on the same tablet the names Eri-[E]aku, probably Arioch, and Kudur-lakhmal, a name mentioned in close connection with Elammat or Elam, and therefore possibly Chedorlaomer.

It is true that there was not much to be learned from the fragment, but it proved to be, in any case, a text of the greatest importance. There is the usual number of references to killing which are to be found in the records of those ancient nations. Besides this, however, we learn that the son of Eri-[E]aku was called Dur-makh-ilâni, that some place was spoiled, and that (apparently) a flood invaded Babylon (or Babylonia) and the great temple called Ê-saggil (or Saggil) within the renowned capital. Then there is a statement to the effect that "the old man and the child [were slain] with the sword," and executions took place. Two lines after the mention of Tudkhula (or Tidal), son of Gazza—, it is stated that "his son (Gazza—'s, Tidal's, or another's) fell upon him with the weapon of his hand," and then "his dominion (?) [was proclaimed?] before the temple (of the goddess) Annunit."

Whether in consequence of these high-handed proceedings or not we do not know, but "[the King of?] Elam spoiled the city Akhkhêlal (?) and the land of Rabbât," rendering [the land] "like heaps of ruins," and capturing,

* The complete form of this name was, possibly, *Gazzani*.

† Properly, this name should be transcribed Tid'al, for a more ancient Tidghal. The Greek gives Thargal, a mistake for Thadgal.

in all probability, "the fortress of Akkad and the whole of Borsippa (?);" after which "Kudur-lakhmal, his son (probably the son of the King of Elam), pierced (?) his heart with the steel sword of his girdle," and afterwards, it is to be supposed, took the throne and "captured his enemy."

The discovery of another tablet which followed shed some light on the names, but did not give a very satisfactory sense. It referred, however, to the above-named Elamite prince, and seemed to state distinctly that he became King of Babylon:—

"[The gods?] in their faithful counsel cared for Kudur-lakhgumal, King of Ela[m]. He descended, and the thing that unto them was good [he performed?], and he exercised sovereignty in Babylon, the city of Kar-Dunias (=Babylonia)."

This passage gives an extra syllable to the name (Kudur-lakhgumal for Kudur-lakhmal), bringing it one degree closer to the Hebrew Chedorlaomer (Greek Chodollogomor), and rendering it probable that it is the same king. Of real history, however, this second fragment does not give much, partly on account of its imperfect state; but it refers to Dur-makh-ilāni, whose father's name is called Eri-ekua (a variant for Eri-Eaku, or Arioch, which the first text gives), and to certain letters which passed, in which he seems to emphasize his superior right to the throne of Babylonia (over that of Kudur-lakhgumal).

It was gratifying to find this second tablet, notwithstanding the imperfect nature of the text. The present writer then, with a view to rendering his translation as

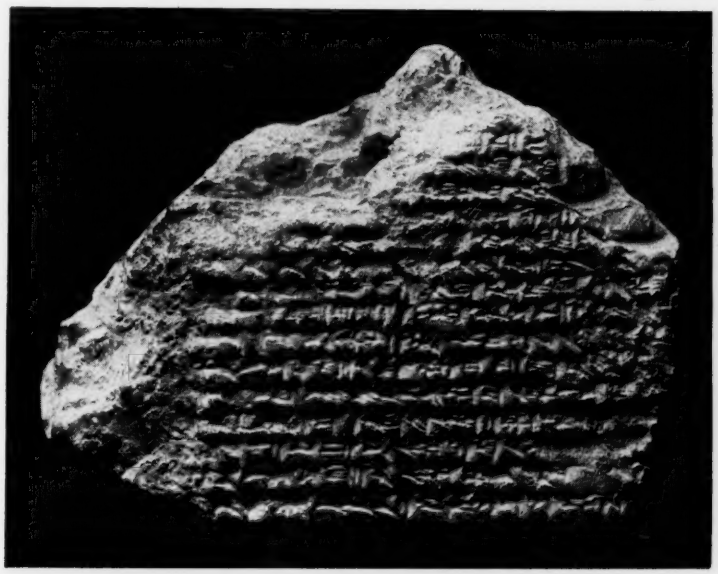


FIG. 1.—Babylonian Tablet. Obverse.

complete as possible by reference to other texts, proceeded to look through his copies for references to words, names, etc., and was agreeably surprised to find on another tablet the name Kudur-lakhgu—, who was called "the Elamite." The completion of this as Kudur-lakhgumal was, as may be imagined, the most natural thing possible, and an examination of this third inscription gave some very interesting items of ancient history.

It is a text divided into paragraphs, and is written in poetical style, resembling, in some things, that of the Creation tablets, which are undoubtedly very ancient as to their composition. This new text, where it begins to be complete, speaks of someone (probably the Elamite whose doings form the subject of the tablet) who descended to Du-makh ("the supreme seat") like *Ura lâ gamil* ("the unsparing pestilence"), and he saw there the temple, and spoke with the children (probably the officials) therein. He then sent a message to all his warriors, (saying) "Carry off the spoil of the temple, take also its goods, take away its image, break down its enclosing wall." "Against the god Ennun-dagalla" ("the guardian of the broad place") "the enemy pressed forward evilly." The god, clothed with light before him, flashed like lightning, and "the enemy was afraid." Nevertheless, he gave instructions to take the crowns of the god, and to "seize his hands" (probably instructions to carry the image out of the temple)—"he did not fear, he did not regard his life," but, notwithstanding this, "he did not remove his crowns." This practically closes the obverse (Fig. 1), the sense of the remaining lines being doubtful in consequence of the mutilation of the text.

The reverse (Fig. 2), which is divided into short paragraphs, continues the narrative after a gap which is probably considerable. The first complete lines tell us that "The enemy, the Elamite, devised evil, and the god Bel devised evil against Babylon." After referring again to the temple, the tablet says: "The enemy, the Elamite, took its goods——, the god Bel had displeasure towards his sanctuary (?)." After several lines in this same strain, in which the unfavourable attitude of the heavenly powers and the elements (*e.g.*, "storm and evil wind went round in the heavens") is referred to, a paragraph occurs in which the question is asked, "Who is Kudur-lakhgumal, the maker of the evils? He has gathered the barbarians . . . the people (?) of the god Bel, he has laid in ruin . . . by their side." "He se[t his face to go] down to the land of Tiamtu" (probably by the Persian Gulf), then ruled, apparently, by a prince named Ide-Tutu. The writer of the tablet, however, again goes back to the misfortunes of the temples, etc., of his beloved country: "[The enemy], the Elamite, directed his yoke and set his face (to go) down to Borsippa . . . The princes he subjugated with the sword, he carried off the spoil of the temples, he took away and carried off to Elam their goods. . . ."

Such is, in short, the contents of these three interesting and remarkable, though mutilated, Babylonian texts. They lose much value by their imperfection—indeed, were they perfect they would probably present no difficulties to the historian, and but few to the translator. Badly preserved as they are, however, it is a matter of great satisfaction that time has spared them to us, for they throw light on a dark period, and one of great interest. Whether Kudur-lakhgumal (better transcribed, perhaps, Kudur-laghgumal) be really Chodollogomor or Chedorlaomer, and Eri-Eaku Arioch, time alone can decide; but the fact that the three names so closely resembling Chedorlaomer, Tidal, and Arioch all occur on the same tablet is, of itself, a great argument in favour of the identifications that have

been proposed. That Kudur-lakhgumal, King of Elam, is the enemy, not the ally, of the King of Babylonia, is probably due to a change in the feelings and policy of the two rulers, and presents no difficulty, as far as our knowledge at present goes. In whatever manner, however, time may compel the student to regard the events these tablets refer to, there can be no doubt as to their real importance. The absence of any reference to an expedition to the valley of the Jordan is probably due to the mutilation of these clay records (one baked, perhaps by the Arabs who found it, and the other two unbaked), but may be due to the fact that they are written exclusively from a Babylonian point of view. They testify, as do other texts, Babylonian and Hebrew, to the power of Elam at a period which Babylonian chronology fixes at rather more than four thousand years ago.

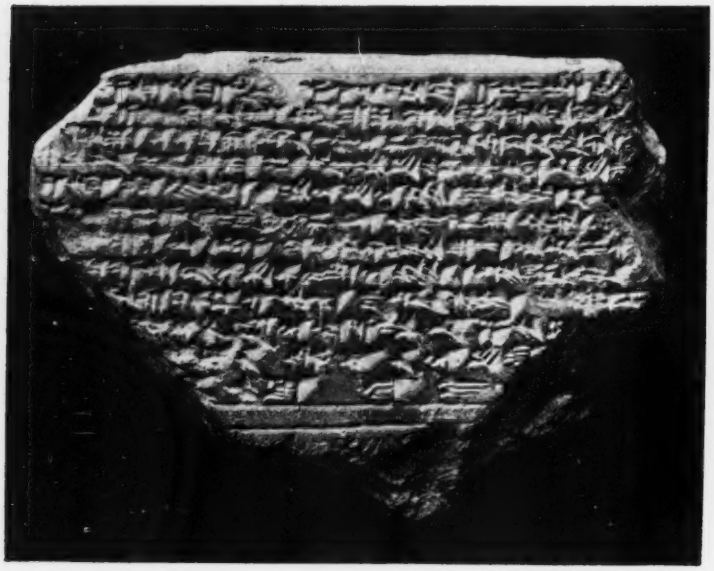


Fig. 2.—Babylonian Tablet. Reverse.

THE FACE OF THE SKY FOR MAY.

By Herbert Sadler, F.R.A.S.

SUNSPOTS and faculæ are still diminishing in number and size.

Mercury is favourably situated for observation during May, being at its greatest eastern elongation (22°) on the **16th**. On the **1st** he sets at 8h. 54m. P.M., or 1h. 30m. after the Sun, with a northern declination of 20° 59′, and an apparent diameter of $5\frac{3}{4}''$, $\frac{8}{10}$ths of the disc being illuminated. On the **5th** he sets at 9h. 21m. P.M., 1h. 54m. after the Sun, with a northern declination of 22° 59′, and an apparent diameter of $6\frac{1}{4}''$, $\frac{67}{100}$ths of the disc being illuminated. On the **10th** he sets at 9h. 46m. P.M., or 2h. 10m. after the Sun, with a northern declination of 24° 32′, and an apparent diameter of 7·0″, $\frac{52}{100}$ths of the disc being illuminated. On the **15th** he sets at 9h. 57m. P.M., or two hours and a quarter after the Sun, with a northern declination of 25° 11′, and an apparent diameter of $7\frac{3}{4}''$, $\frac{4}{10}$ths of the disc being illuminated. On the **20th** he sets at 9h. 56m. P.M., or 2h. 6m. after the Sun, with a northern declination of 25° 3′, and an apparent diameter of $8\frac{3}{4}''$, $\frac{27}{100}$ths of the disc being illuminated. On the **25th** he sets at 9h. 42m. P.M., or one hour and three-quarters after the Sun, with a northern declination of 24° 19′, and an apparent diameter of 10·0″, $\frac{17}{100}$ths of the disc being illuminated. On the **30th** he sets at 9h. 16m. P.M., or one and a quarter hours after the Sun, with a northern declination of 23° 8′, and an apparent diameter of 11·0″, $\frac{1}{10}$th of the disc being illuminated. He is at his brightest about the **2nd** of the month. During May he pursues a direct path through nearly the whole of Taurus, being about 2° south of the Pleiades on the evening of the **2nd**.

Venus is too near the Sun to be observed, and Mars is, for the purposes of the amateur, invisible.

Jupiter is still a conspicuous object in the evening sky, but is rapidly nearing the west. On the **1st** he sets at 1h. 35m. A.M., with a northern declination of 20° 35′, and an apparent equatorial diameter of 37·0″, the phase on the *f* limb amounting to $\frac{1}{3}''$. On the **10th** he sets at 1h. A.M., with a northern declination of 20° 20′, and an apparent equatorial diameter of $36\frac{1}{4}''$. On the **20th** he sets at 0h. 26m. A.M., with a northern declination of 20° 1′, and an apparent equatorial diameter of $35\frac{1}{4}''$. On the **30th** he sets at 11h. 45m. P.M., with a northern declination of 19° 39′, and an apparent equatorial diameter of $34\frac{1}{3}''$. During the month he describes a direct path in Cancer, being rather more than $\frac{3}{4}$° south of the $5\frac{1}{2}$ magnitude star η Cancri on the **23rd**. The following phenomena of the satellites occur while the Sun is more than 8° below and the planet 8° above the horizon:—On the **1st** an occultation disappearance of the second satellite at 9h. 28m. P.M.; an eclipse reappearance of the third satellite at 11h. 42m. 46s. P.M. On the **2nd** an occultation disappearance of the first satellite at 9h. 50m. P.M. On the **3rd** a transit egress of the shadow of the second satellite and a transit egress of the first satellite at 9h. 26m. P.M.; a transit egress of the shadow of the first satellite at 10h. 42m. P.M. On the **8th** a transit ingress of the shadow of the fourth satellite at 10h. 5m. P.M., an occultation reappearance of the third satellite at 10h. 45m. P.M. On the **9th** an occultation disappearance of the first satellite at 11h. 47m. P.M. On the **10th** a transit ingress of the first satellite at 9h. 3m. P.M.; a transit ingress of the shadow of the second satellite at 9h. 7m. P.M.; a transit egress of the second satellite at 9h. 38m. P.M.; a transit ingress of the shadow of the first satellite at 10h. 16m. P.M; a transit egress of the first satellite at 11h. 23m. P.M. On the **11th** an eclipse reappearance of the first satellite at 9h. 48m. 14s. P.M. On the **15th** an occultation disappearance of the third satellite at 11h. 16m. P.M. On the **16th** an occultation disappearance of the fourth satellite at 8h. 43m. P.M. On the **17th** a transit ingress of the second satellite at 9h. 26m. P.M.; a transit ingress of the first satellite at 11h. 1m. P.M. On the **19th** a transit egress of the shadow of the first satellite at 9h. P.M.; an eclipse reappearance of the second satellite at 9h. 16m. 55s. P.M.; a transit egress of the shadow of the third satellite at 9h. 50m. P.M. On the **25th** an occultation disappearance of the first satellite at

10h. 14m. P.M. On the **26th** a transit egress of the third satellite at 9h. 20m. P.M.; a transit egress of the first satellite at 9h. 48m. P.M.; a transit ingress of the shadow of the third satellite at 10h. 7m. P.M.; a transit egress of the shadow of the first satellite at 10h. 55m. P.M.

Saturn is an evening star, and is in opposition to the Sun on the **5th**. On the **1st** he rises at 7h. 27m. P.M., with a southern declination of 14° 14′, and an apparent equatorial diameter of $17\frac{3}{4}''$ (the major axis of the ring system being $43\frac{1}{4}''$ in diameter, and the minor $15\frac{3}{4}''$). On the **13th** he rises at 6h. 34m. P.M., with a southern declination of 13° 58′, and an apparent equatorial diameter of $17\frac{3}{4}''$ (the major axis of the ring system being $43\frac{1}{4}''$ in diameter, and the minor $15\frac{1}{2}''$). On the **27th** he rises at 5h. 33m. P.M., with a southern declination of 13° 42′, and an apparent equatorial diameter of $17\frac{1}{2}''$ (the major axis of the ring system being 43″ in diameter, and the minor $15\frac{1}{4}''$). Titan is at his greatest eastern elongation at 10h. P.M. on the **2nd**, and 7h. 30m. P.M. on the **18th**. He pursues a retrograde path through a barren region of Libra.

Uranus is in opposition to the Sun on the **12th**, and is an evening star, but his great southern declination militates against successful observation in these latitudes. On the **1st** he rises at 8h. 14m. P.M., with a southern declination of 18° 13′, and an apparent diameter of 3·8″. On the **31st** he rises at 6h. 9m. P.M., with a southern declination of 17° 56′. He pursues a retrograde path in Libra.

Neptune has left us for the season.

There are no very well-marked showers of shooting stars in May.

The Moon enters her last quarter at 3h. 25m. P.M. on the **4th**; is new at 7h. 46m. P.M. on the **12th**; enters her first quarter at 6h. 21m. A.M. on the **20th**; and is full at 9h. 57m. P.M. on the **26th**. She is in apogee at 3h. P.M. on the **8th** (distance from the Earth, 252,050 miles), and in perigee at 11h. A.M. on the **24th** (distance from the Earth, 225,080 miles).

Chess Column.

By C. D. LOCOCK, B.A.Oxon.

Communications for this column should be addressed to C. D. LOCOCK, Burwash, Sussex, and posted on or before the 10th of each month.

Solution of April Problem.

(C. A. Kennard.)

Key-move.—1. R to QBsq.

If 1. . . . K to Q4, 2. K to B3, etc.
1. . . . P to Q4, 2. R to K2, etc.

The "curiosity" lies in the fact that if White could make a waiting move there would be a second solution: for after 1. K to Q4, 2. P to Q4, and mates next move.

CORRECT SOLUTIONS received from Alpha, J. T. Blakemore, A. Walker, W. Willby.

R. P. Greg.—There is hardly enough variety in your problem, considering the force employed.

W. Willby.—It was certainly an unusual feat.

A. C. Challenger.—Many thanks for the problems, especially the three-mover.

W. M. A. E.—After 1. K to Kt2, P to Q4; 2. R to K2, K to Q6, there is no mate.

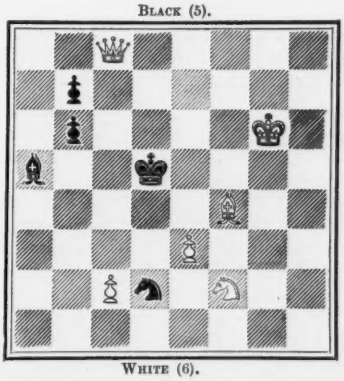
G. B. Fraser, A. E. Bramall, and A Norseman.—Your communications have been forwarded to our correspondent.

PROBLEMS.

By A. C. Challenger.

No. 1.

BLACK (5).

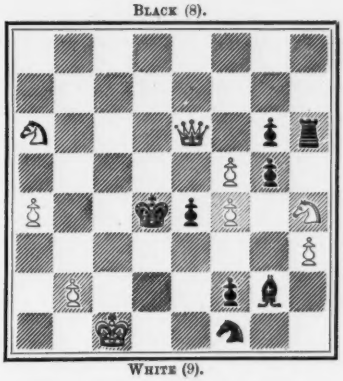


WHITE (6).

White mates in two moves.

No. 2.

BLACK (8).



WHITE (9).

White mates in three moves.

THE EIGHT QUEENS PROBLEM.

Some correspondents have sent us some remarks on this problem which may tend to explain the law which governs it.

Mr. W. W. Strickland shows that the paucity of solutions on a board of thirty-six squares (using six Queens) is connected with the fact that the solution is impossible when a Queen stands in the centre of one of the four quarters of the board. From other considerations he predicts that on a board of eighty-one squares there will be found only six essential methods of solving the problem. Perhaps one of our readers might care to verify this. Mr. C. W. Branch suggests the law which governs the convertibility or otherwise of the positions. He imagines a position set up on *nine* chess-boards placed in the form of a square. If, then, any piece on one of the outside chess-boards is in a line with any piece on the central board, the central position cannot be moved in such a direction as to cause the attacking piece to be brought on to the central board, unless such movement at the same time causes the piece attacked to disappear from the central board.

We regret that it is impossible to print the diagrams which accompany this ingenious explanation.

XUM

CHESS INTELLIGENCE.

The secretary of the newly established "Courts Chess Club" informs us that the club meets at 93, Chancery Lane. The members are mostly connected with the legal profession.

The Inter-University Chess Match was played at the British Chess Club last month, and resulted in a victory for Oxford. The following was the score:—

OXFORD.		CAMBRIDGE.	
1. E. Lawton, capt. (Corpus)	1	W. V. Naish, capt. (Emm.)	0
2. E. G. Spencer Churchill (Magdalen)	1	G. Varley (Christ's)	0
3. H. G. W. Cooper (Oriel)	0	W. T. Quin (Caius)	1
4. H. N. Robbins (Corpus)	0	E. A. Crowley (Trinity)	1
5. R. A. Jenkins (Brasenose)	1	R. Battersby (St. Cath.)	0
6. G. Fraser (Corpus)	½	H. F. Parker (Emm.)	½
7. A. S. Ward (Balliol)	½	C. C. W. Sumner (St. John's)	½
	4		3

Mr. Robbins lost a game, which he should have won, by exceeding his time-limit. Cambridge are still seven matches to the good, out of the twenty-four played since 1873.

The score in the Steinitz-Schiffers match is:—Schiffers, 4; Steinitz, 6; drawn, 1.

Mr. H. W. Trenchard has just won a match with Mr. J. Mortimer, and drawn one with Mr. Herbert Jacobs.

The Annual Chess Festival of the Hastings Chess Club took place on March 16th to 19th. Messrs. Bird, Blackburne, and Teichmann gave simultaneous and blindfold performances, and there were the usual consultation games.

The Amateur Championship Tournament begins at the City of London Chess Club on April 20th. About the same time there will be a Masters' Tournament at Simpson's Divan.

In the Vienna Club Tourney the leading scores are now:—Englisch and Schlechter, 11; Marco and Weiss, 10½; J. Schwarz, 10.

The following game was played in the Universities' Match last month:—

"Petroff's Defence."

WHITE. (G. Fraser, Oxford.)	BLACK. (H. F Parker, Cambridge.)
1. P to K4	1. P to K4
2. Kt to KB3	2. Kt to KB3
3. Kt to B3	3. Kt to B3
4. B to B4 (*a*)	4. B to B4
5. P to Q3	5. P to Q3
6. B to KKt5 (*b*)	6. B to K3
7. B × B (*c*)	7. P × B
8. Kt to K2	8. Castles
9. Kt to Kt3	9. Q to Q2
10. P to KR3 (*d*)	10. Kt to Q5
11. P to B3	11. Kt × Ktch
12. P × Kt	12. R to B2
13. P to Q4	13. P × P
14. P × P	14. B to Kt3
15. Q to Q3 (*e*)	15. QR to KBsq
16. Castles QR	16. Kt to Ksq
17. B to K3	17. R × P
18. QR to Ktsq	18. P to B3
19. P to Q5	19. P to K4 (*f*)
20. Kt to B5	20. K to Rsq (*g*)
21. Q to K2	21. B × Bch
22. P × B	22. R(B6) × Kt
23. P × R	23. P × P
24. Q to Kt4	24. R × P
25. R to Bsq	25. P to KKt3
26. R × R	26. P × R
27. Q to Kt3 (*h*)	27. Kt to Kt2
28. Q to Kt2	28. P to K5 (*i*)
29. Q to Q2	29. Drawn.

NOTES.

(*a*) An inferior variation of the Four Knights game. Black should reply 4 . . . Kt × P. The correct move is 4. B to Kt5.

(*b*) Inferior to 6. B to K3.

(*c*) Again bad judgment: for now his Knight can never enter at Q5, so that his Queen's Bishop is in a useless position, as Black will be able to escape from the "pin."

(*d*) Unnecessary. He might play 10. P to B3. On his next move it is too late, as he thereby gets a very weak doubled Pawn, which is speedily lost.

(*e*) He should make some attempt to defend the KBP by means of the QR and the King.

(*f*) So far Black has played excellently, but this mistake loses him all his advantage. He should play 19 . . . BP × P first.

(*g*) 20 . . . B × Bch would save a move if not more.

(*h*) 27. Q to Kt5 looks stronger; or Q to Kt2 at once. On his next move the obvious 28. R to Ktsq seems best.

(*i*) This move weakens all his Pawns; but in any case the game would probably be drawn.

CONTENTS OF No. 126.

	PAGE
Electrography; or the New Photography. By J. W. Gifford. (*Illustrated*)	73
Novel Experience with Röntgen Rays	76
Aluminium: Its History, Manufacture, and Future.—I. By Samuel Rideal, D.Sc.Lond., F.I.C.	76
Waves.—IV. Ship Waves, and the Solitary Wave. By Vaughan Cornish, M.Sc. (*Illustrated*)	78
Notices of Books	81
Science Notes	83
Letters:—H. Stanley Williams; W. E. Besley; W. Lyon Browne, jun.; I. G. Ouseley	83
Pliny and Cuvier. By E. Walter Maunder, F.R.A.S.	85
The Spectrum of Helium. By E. Walter Maunder, F.R.A.S. (*Illustrated*)	86
The Birch. By George Paxton. (*Illustrated*)	90
Greek Vases.—II. A.—Vases of the Primitive Period, to 600 B.C. By H. B. Walters, M.A., F.S.A. (*Illustrated*)	91
The Face of the Sky for April. By Herbert Sadler, F.R.A.S.	94
Chess Column. By C. D. Locock, B.A.Oxon.	95

THREE PLATES.—1 and 2. Electrographs of Various Subjects. 3. Plinius and Cuvier and Licetus.

NOTICES.

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